POWER

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Ben Grant, Engineer

With apologies to the late John Hay

Well, no! I can't say where he works,
'Cause he don't work ye see;
Leastways he's got out of the habit
Of working like you and me.
What? Wher've ye been for the last three years
That ye havn't heard folks say
About the courage and grit Ben Grant displayed
At that there mill one day?

Ben wa'n't no saint—he could take a glass
Like many an engineer.
But what if he did? 'taint many of us
But what tikes his glass of beer!
A keerless man in his talk was Ben,
He would up and cuss and scold,
But the power-plant force all swore by him—
They knew he was "good as gold."

And the only religion he ever had
Was to treat his subordinates right,
'Tend strictly to business when 'round the plant,
Whether by day or night;
And when anything happened about the plant,
No matter where or when,
Big Ben was "Johnny on the spot"
A looking after his men.

That mill there is an old affair,
The oldest in the state,
And spite o' all Ben's recommends,
The plant wa'n't up to date.
He'd warned the owners time and again,
But he couldn't make 'em believe
That a nonreturn was a mighty good thing,
Or that a blowoff pipe needed a sleeve.
"We've run without 'em," the Super said,
"For many a year and a day,
And there'd be no end to the money we'd spend
If you engineers had your way."

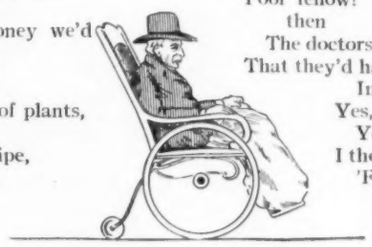
Well, accidents come to the most of plants,
And at last there came a day
When a fittin' bust on a blowoff pipe,
And then there was hell to pay.

"A hundred and sixty" the gages showed,
Six boilers connected in—
No nonreturns on any one—
Perhaps there wasn't some din.

The boiler room was filled with steam,
While over the concrete floor
Three inches of boiling water flowed,
Clean up to the engine room door.
There was runnin' and cussin', but Ben yelled out
Over all the infernal roar,
"I'll cut her out boys, keep your heads!"
As he bounded through the door.
They all had faith in his cussedness,
And everyone that heard
Placed full dependence on what he said,
For they knowed that he'd keep his word.
And as sure as you're born, they all kept safe
And clear from that blast of steam—
But poor old Ben, as brave as he was,
Let out an awful scream.

No trenches were built in the concrete floor
To carry away the flood
When such a thing as this occurred—
Poor Ben was sweating blood.
For he'd stepped plum into that hellish lake
That from the boilers ran,
But spite o' that he "cut her out"
And proved himself a man.

With all the doctoring he had—
And they gave him the best of care—
Poor Ben can never walk again,
They wheel him in a chair.
Poor fellow! He suffered for weeks, and then
The doctors told his wife
That they'd have to amputate both feet
In order to save his life.
Yes, I'm an engineer myself!
You bet I've got 'em! Say!
I thought I'd lock the stable door
'Fore the hosses got away.



H. R. Low, Moosup, Conn.

Hot-Water Heating at Plant of the Crane Co., Chicago—I

By Thomas Wilson

SYNOPSIS—A modern system of seven circuits designed to care for 600,000 sq.ft. of radiation in 49 buildings. Heaters arranged on unit basis and supplied with exhaust steam under automatic control. Air successfully removed from hot-water circuit by steam traps. Coils, supports and fittings standardized to facilitate equipping new additions to works.

The Crane Co., in its new works at Corwith, near the southwestern boundary of Chicago, has one of the most modern and largest institutions of the kind in the country. The site, containing 151 effective acres, is bounded by Kedzie Ave. on the east, extending back to the Santa Fe shops on the west, by 39th St. on the north and 43rd St. on the south. The total building frontage on Kedzie Ave. is 2,470 ft. From north to south the buildings are divided into six groups, lettered from A to F. Each group extends westward from Kedzie Ave., the buildings being numbered consecutively. The A and F groups receive the raw material, and it is passed through the works systematically, the finished product being delivered for shipment from the central groups. Although some of the departments are still located at the older plants of the company, the new site now contains twenty-seven buildings having an aggregate floor space of 25 acres. The finished plans call for forty-nine buildings having a floor area of 50 acres. Most of the buildings are two stories high without basement. The administration building fronting the C and D groups is five stories high.

Electric industrial trucks afford means of transportation between departments and between the various buildings, while water, steam, air and oil are supplied through a system of interconnecting tunnels. All buildings are of modern reinforced concrete construction. Including land, buildings, machinery and all equipment, the cost of the plant complete will approximate $10,000,000.

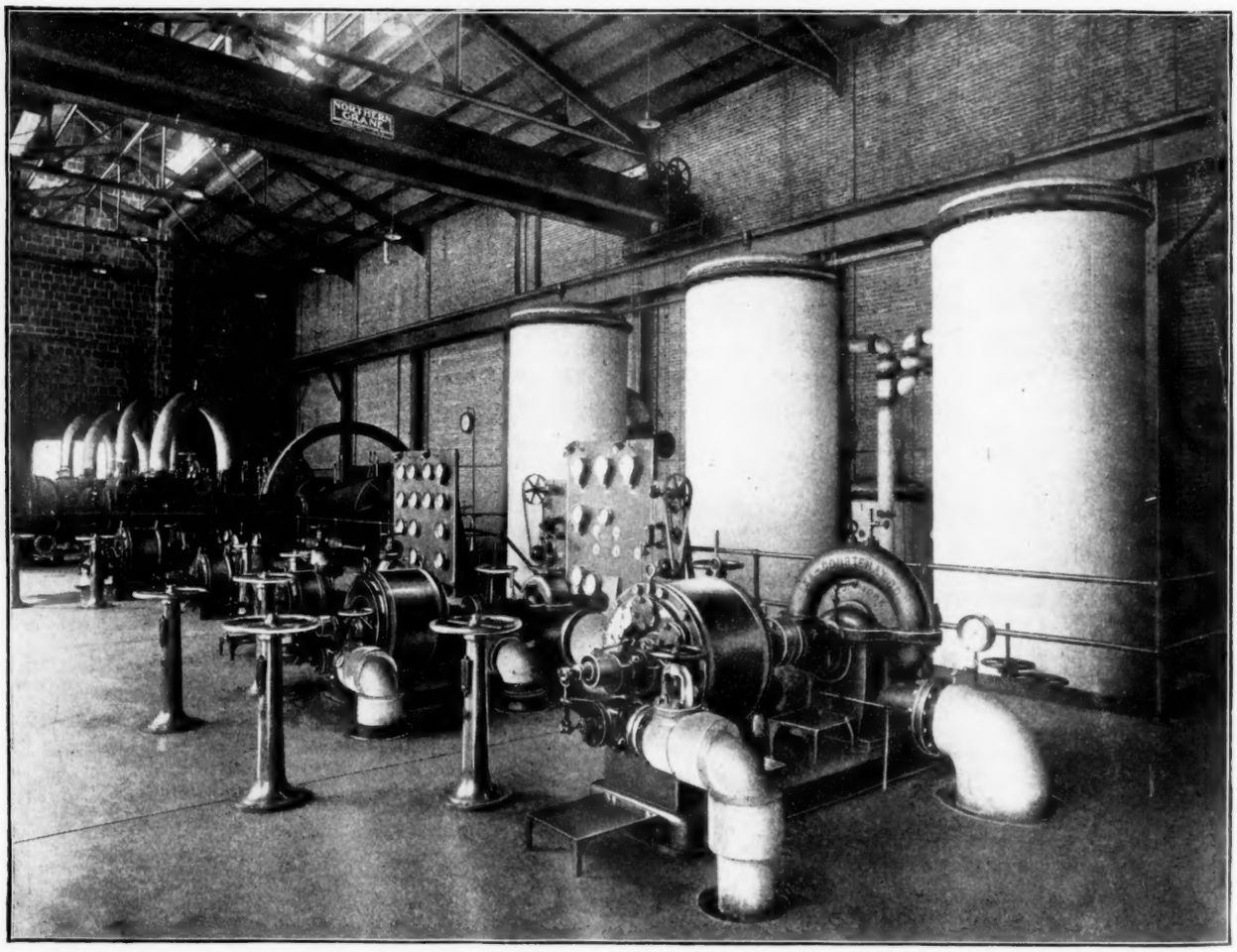


FIG. 1. HOT-WATER HEATERS AND PUMPS IN COMPRESSOR ROOM

As the buildings spread over a large area and have no basement, it was decided that hot water under forced circulation would be the most efficient medium for heating. Months of investigation tended to prove that this system would be the easiest to operate and maintain, and would give better service than steam.

Last winter 193,000 sq.ft. of direct radiation was in service. By next fall there will be 275,000 sq.ft., and as buildings are added this total will be increased. The heaters, pumps and boilers are in a central plant 920 ft. back from Kedzie Ave. This plant supplies steam to two large air compressors, live steam at high pressure and superheat for testing purposes and steam at medium pressure for the same purpose. In addition, large quantities of water for domestic service must be heated, and a 50-ton absorption refrigerating plant is installed to cool the drinking water. Except in the very coldest weather there has been sufficient exhaust steam from the air compressors and the various pumps to supply all demands. In other words, the supply and the demand for exhaust steam were very nearly balanced.

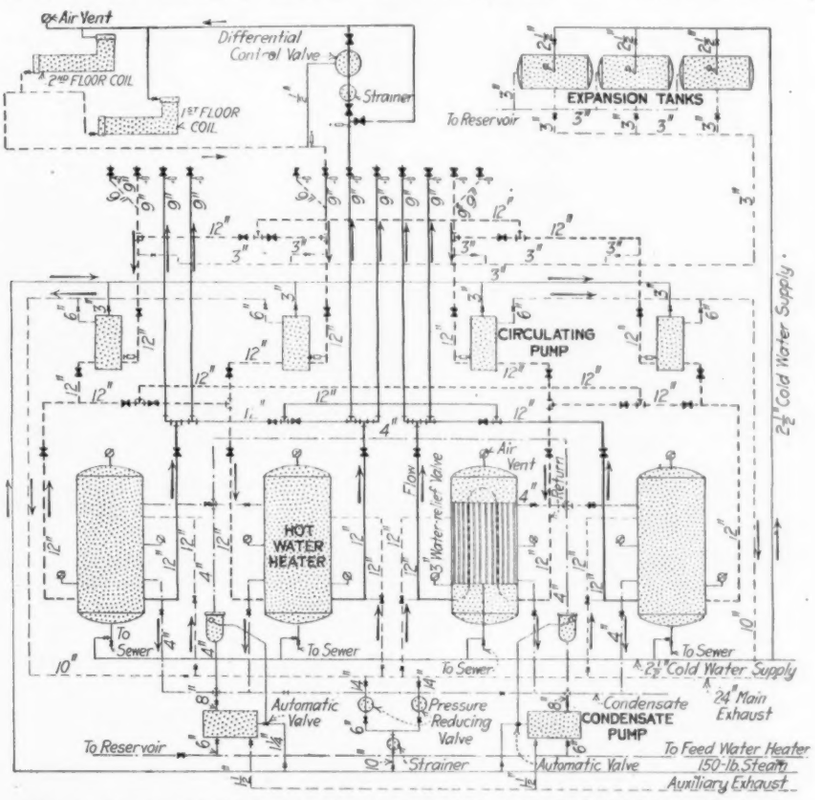


FIG. 2. DIAGRAMMATIC SKETCH OF WATER AND STEAM CONNECTIONS TO HEATERS

Instead of heating the entire plant from one circuit, which would have necessitated the use of exceptionally large piping, the heating system has been divided into seven circuits. Six of these supply the shops, and the seventh supplies the administration building, which requires heat at times when the shops can do without it. For the works or shop heating there are four heaters, three of which are capable of taking care of all heating that may be needed for the future plant. Each heater serves two circuits and is designed for 200,000 sq.ft. of radiation. With its respective pump it forms a unit independent of the others, although all are cross-connected, as shown in the diagrammatic view of connections, Fig. 2. The fourth heater is a reserve unit so connected that it can take the place of any one of the other three. All the heaters are of the same size, being 72 in. diameter and 20 ft. long. They are of the two-pass type and each contains 3,600 sq.ft. of heating surface in 484 tubes 2 in. diameter and 14 ft. long.

The circulating pumps are of the double-suction volute type driven by steam turbines at speeds of 2,750 and 1,600 r.p.m In the various circuits the water is circulated at an approximate velocity of 200 ft. per min. against a head of 92 ft. Exhaust steam from these turbines is discharged into the large main exhaust from the air compressors. From this main 12-in. connections lead into each heater.

To properly regulate the temperature of the water in the various circuits a Powers system of temperature control has been utilized. The flow line leading from each heater is provided with a thermostat operated by compressed air, and this thermostat controls automatically a diaphragm valve mounted on the steam supply to the heater. The thermostats are adjustable over a considerable range of temperature, and by a unique air-motor appliance may be adjusted to the various temperatures desired by means of adjustment switches located on a central board in the compressor room. This service board carries, in addition to the adjustment switches for the several heaters, a set of temperature-recording thermometers, one for each of the heating circuits. These thermometers are of the double-registration type, and their sensitive bulbs are located in both flow and return lines so that the recording chart presents a continuous record of the water temperature as it leaves the power house and also as it comes back. The operating engineer, by observing the outdoor weather condition, may set his adjustment switches to send the hot water out on the various circuits at the proper temperature and thus have before his eye, or ready for observance at any time, a chart record of the performance of the apparatus and the amount of heat given out from the different circuits from the time the hot water leaves the station until it returns.

Compressed air for the operation of this system is developed by electric motor-driven compressors installed in duplicate, one on each side of the service board. These compressors are under automatic control, operating only when necessary to maintain the 15-lb. air pressure used in the operation of the control system.

Near the control board are floor stands for the manipulation of the main valves in the various circuits. These stands are provided with indicators to show exactly the positions of the valves.

Condensation and Live-Steam Connections

A float chamber on the side of each heater controls the removal of condensation, which is effected by a vacuum pump for every two heaters, discharging into two open feed-water heaters operating in parallel and belonging to the boiler plant. Should the feed-water heaters be out of service, the condensation may be discharged into a large service reservoir under the building

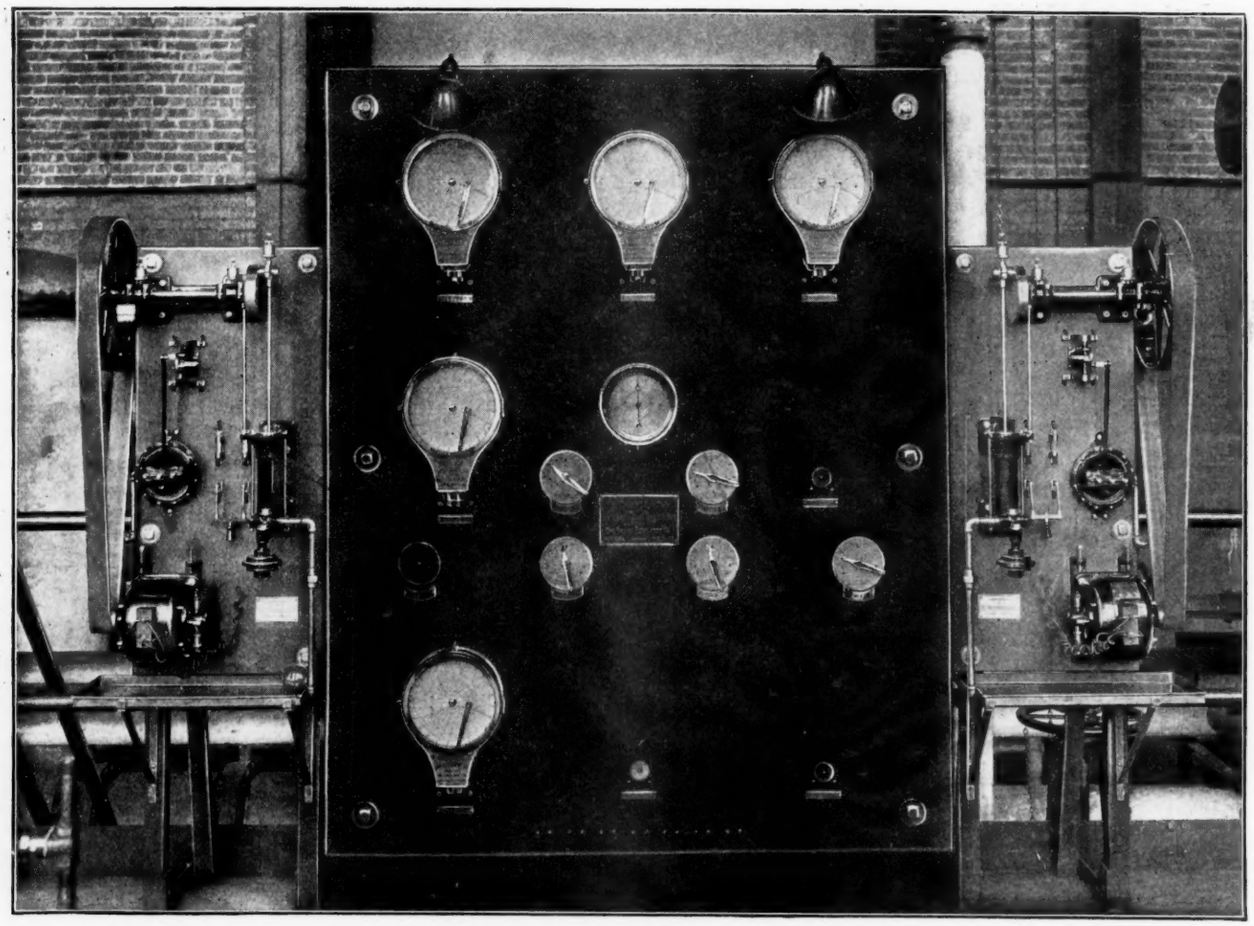
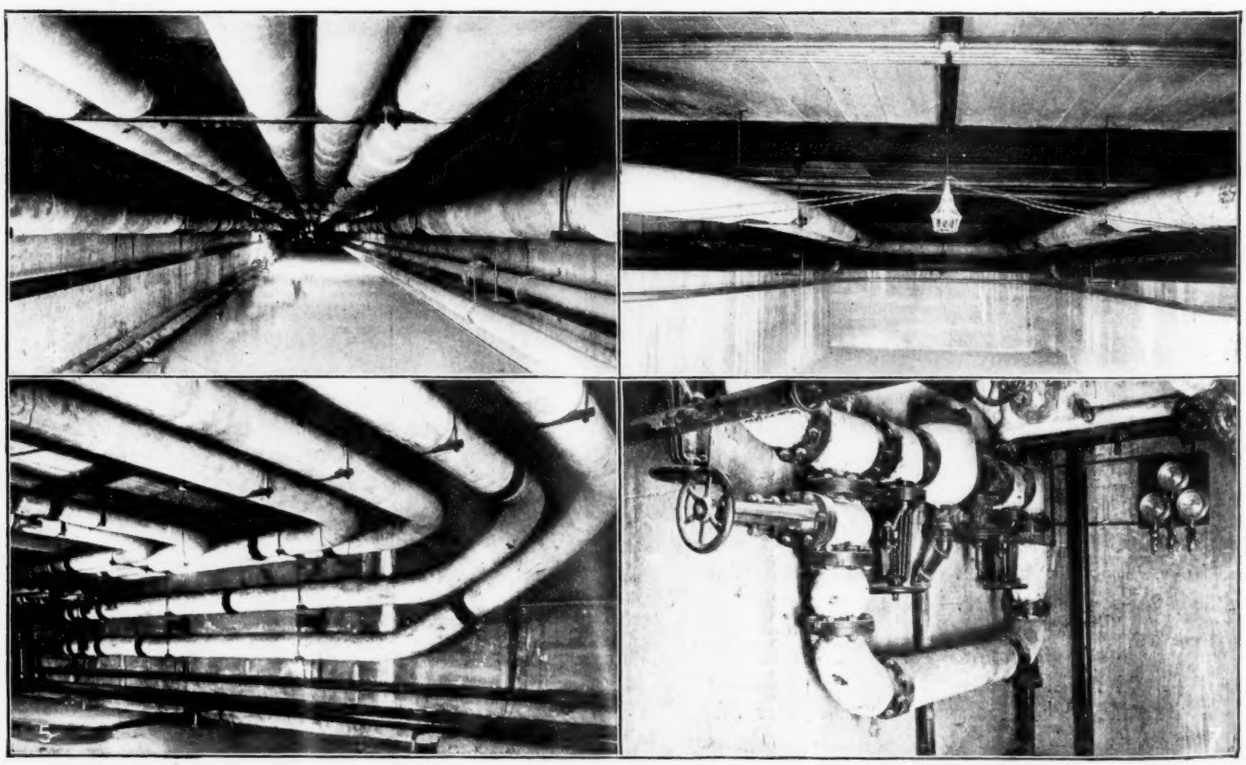


FIG. 3. POWERS SYSTEM OF AUTOMATIC HEAT REGULATION



FIGS. 4 TO 7. VIEWS OF TUNNEL PIPING AND THE DIFFERENTIAL VALVE

Fig. 4—Main tunnel looking west. Fig. 5—Tunnel at turn, showing pipe bends. Fig. 6—Expansion recess in north tunnel. Fig. 7—Typical differential valve controlling water to building.

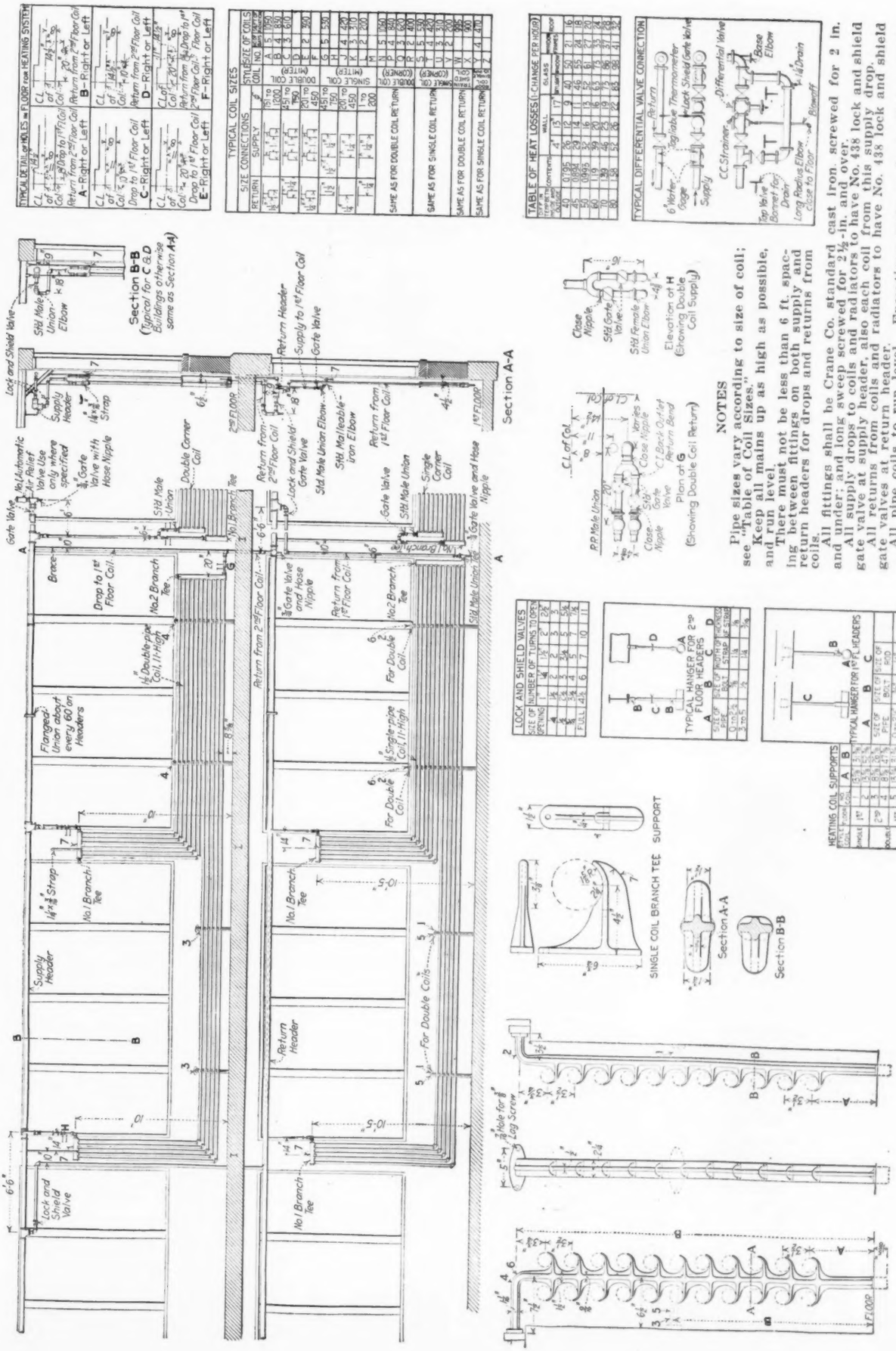

TYPICAL DETAIL of HOLES in FLOOR for HEATING SYSTEM
A-Right or Left
B-Right or Left
C-Right or Left
D-Right or Left
E-Right or Left
F-Right or Left
TYPICAL COIL SIZES
TABLE OF HEAT LOSSES (1° CHANGE PER HOUR)
TYPICAL DIFFERENTIAL VALVE CONNECTION
Section B-B (Typical for C & D Buildings otherwise same as Section A-A)
Section A-A
NOTES
Pipe sizes vary according to size of coil; see "Table of Coil Sizes."
Keep all mains up as high as possible, and run level.
There must not be less than 6 ft. spacing between fittings on both supply and return headers for drops and returns from coils.
All fittings shall be Crane Co. standard cast iron screwed for 2 in. and under; and long sweep screwed for 2½-in. and over.
All supply drops to coils and radiators to have No. 438 lock and shield gate valve at supply header, also each coil from this supply drop.
All returns from coils and radiators to have No. 438 lock and shield gate valves at return header.
All pipe coils to run level. Exceptions were made to these standards in the single-story high buildings, where sizes were increased.
LOCK AND SHIELD VALVES
TYPICAL HANGER FOR 2ND FLOOR HEADERS
TYPICAL HANGER FOR 1ST FL. HEADERS
HEATING COIL SUPPORTS
SINGLE COIL BRANCH TEE SUPPORT

FIG. 8. STANDARD DETAILS OF HEATING SYSTEM

As will be apparent in the diagrammatic sketch, Fig. 2, a 10-in. connection is made to the 150-lb. saturated-steam supply. The 10-in. line contains a strainer and branches out into two 6-in. lines leading into pressure-reducing valves, which lower the pressure to 2 lb. gage and discharge the steam into 14-in. pipes leading into the large exhaust main supplying the heaters. As previously stated, this makeup steam is seldom required, as there has been with few exceptions sufficient exhaust steam to meet all demands.

Office-Building Circuit

For the office building circuit a duplicate installation consisting of two heaters and two pumps has been provided. No deviation has been made in the arrangement or control. These heaters are also of the two-pass type, being 48 in. diameter and 11 ft. high. Each contains 650 sq.ft. of heating surface in 207 steel tubes 2 in. diameter and 6 ft. long. The pumps have a capacity of 320 gal. per min. and operate at a speed of 2,100 r.p.m. against a head of 120 ft. The water velocity in the circuit is 300 ft. per min. As in the works heaters, no attempt is made to alter the amount of heat supplied by changing the speed of the pump or velocity of flow. Regulation is on the steam end, the amount of exhaust steam entering the heater being controlled by the Powers system previously mentioned.

Connecting the boiler and heating plant with the various buildings there is at present 3,220 ft. of tunneling. This is made up of 770 ft. of 15-ft. tunnel, 1,050 ft. of 8-ft. tunnel and 1,400 ft. of 6-ft. tunnel. The main 15-ft. tunnel running east from the boiler plant connects with two north and south tunnels 8 ft. wide, and these are joined by east and west lateral tunnels 6 ft. wide. These tunnels have a number of features worthy of mention. At specified intervals 2x8-ft. openings have been provided to permit piping to be taken in or out of the tunnels. Most of the piping is suspended from the ceiling, the hangers being spaced uniformly on 10-ft. centers. The lower edges of the steel beams have been left open to give free access for the clamps of the hangers without the necessity of cutting away the concrete. Long-radius bends at the turns and the accessibility of the piping are features which the illustrations bring out. Expansion of the piping is taken care of by horizontal U-bends. Recesses in the sides of the tunnels 30 ft. deep in the main runs and 20 ft. deep in the laterals have been provided. At these points 2x15-ft. openings admit the pipe bends. The tunnels are well lighted and drained, and ample provision has been made for future additions.

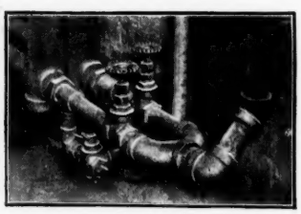


FIG. 9. RETURN-COIL CONNECTION, SHOWING UNION TEES

The mains supplying the shop buildings are 9 in. diameter and those heating the administration building, 6 in. Admission of water to each building is regulated by a differential control valve in the supply line, the pressure control being tapped to the return side of the circuit. These valves are in the tunnels and are protected in each case by a strainer. A bypass permits the control valve to be cut out of service for inspection or repairs.

In the shop buildings, which are mostly two-story structures, the supply and return mains are hung from the ceilings of the second and first floors respectively, close up to the walls above the windows so as to facilitate the hanging of countershafts. Connections are so made to the mains that the first coil fed is the last picked up on the return, thereby balancing the flow of water to the coils and preventing short-circuiting. To control the supply of water to each coil there is a lock and shield valve near the main on each supply and return connection. The type of coil, arrangement and size of connection, coil supports, etc., have been standardized and the various parts lettered or numbered, as shown in Fig. 8, so that it will be easy to equip new buildings as they are completed.

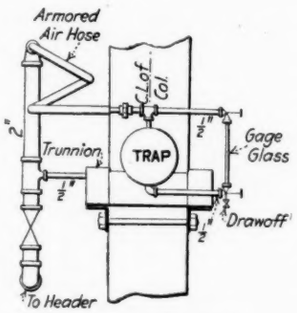


FIG. 10. AIR-TRAP CONNECTIONS

Owing to the large amount of window area double miter coils have been employed, with the vertical elements rising on the pilasters. As shown in Fig. 8, each vertical element is fed from the supply main at the ceiling of the second floor. The two coils connect to a common manifold at the end of the horizontal runs, which terminates in a connection to the return header on the ceiling of the floor below. The feeds for the first floor coils drop through the second floor to the manifolds on the vertical elements, and the single manifold joining the horizontal runs discharges to the return main on the ceiling. On the opposite sides of the hangers are duplicate coils, details of the double-coil supply and return being shown in the illustration just referred to. This drawing also shows the double and single hangers and a typical differential-valve connection controlling the flow of water to the building. All supply connections are taken off the main header on not less than 6-ft. centers, and throughout each installation union ells and union tees cut down the number of joints.

Cranetilt Traps Remove Air

In all hot-water heating installations one of the chief troubles is to relieve the system of air. In the present work this difficulty has been ingeniously met by installing at the highest point of the feed riser a special ½-in. direct-return Cranetilt trap. A 2-in. pipe rises from the supply header to a point above the trap, terminating in a reducing ell and nipple from which a ½-in. armored hose connects to the top of the trap drum. A ½-in. tee connection from the 2-in. pipe enters the trunnion.

Water from the heating system fills the trap. The air in the system accumulates at the highest point, rises through the 2-in. pipe previously mentioned and displaces the water in the trap, driving it back into the heating line until the trap is filled with air. The counterweight then drops, and the air is discharged to the atmosphere, while the water rushes back into the trap from the heating line. The same operation is repeated as often as necessary. It will be apparent that the usual opera-

tion of the trap is reversed. Such an installation has been in operation all winter and has given excellent results.

In the administration building, which has 12,000 sq.ft. of direct radiation, the system is practically identical to that in the shops with the exception that radiators are used instead of coils. The 6-in. supply in the tunnel terminates in a 5-in. main rising to the ceiling of the fifth floor. Drops from this main care for the radiation on the floors below. The return header, as usual, is located at the ceiling of the first floor. Owing to the head on the radiators an unusual velocity of water is maintained and the heating is more rapid than in the shop buildings. On Aug. 22, 1915, heat was required in the administration building. The pump on the office system was started, and in 25 min. there was a noticeable temperature in the radiators. This may be compared to 4 or 4½ hr. required to bring the temperature up in the two-story shop buildings.

In the next issue a description of the boiler and compressor plant and a tabulated list of the equipment will be given.

Direct-Current Armature Windings

By John A. Randolph

SYNOPSIS—An elementary discussion of the types of armature windings and the process of commutation.

The action of an armature winding depends primarily upon the well-known principle that electromotive force is generated in a conductor whenever it is moved transversely through a magnetic field. When the two ends of the conductor are joined, the induced pressure will cause a current to flow in a direction depending upon the direction of the flux and the movement of the conductor. One of the most common and convenient methods of determining the direction of current is that consisting in the use of the thumb and first two fingers of the right hand. If these three members are extended in such a manner that any one will be at right angles to the other two, as shown in Fig. 1, and the directions in which they point are made to respectively represent the directions of motion, flux and current, any one of the three quantities thus represented can be determined if the other two are known.

An armature winding consists of a number of insulated conductors placed upon an iron core and interconnected in such a manner that when revolved in a magnetic field, the electric energy induced therein can be collected for external use by means of a commutator or a set of slip-rings.

There are various methods of connecting the conductors, depending upon the kind of core used and the service for which the machine is designed. However, they may all be grouped under two headings, namely, open-coil windings and closed-coil windings. In the former type the coils are connected together in independent groups, the groups being so connected to the commutator that only the coils that form a part of the working circuit in which the electromotive force has reached a maximum are in service at any one time; the other coils, at this instant are open-circuited. This class of winding is confined to the ring armature and is now found only on arc-light machines. Its chief advantage is that it can be used for the generation of high voltages without unduly increasing the number of commutator segments. This is possible because there is no difference of potential between consecutive commutator segments on account of their being connected to independent circuits. Fig. 2 illustrates the connections of an open-coil armature. It will be observed that coils *A* and *B*, which have reached the position of maximum voltage, are connected through the brushes to the external circuit, while the coils *C* and *D*, in the position of minimum voltage, are open-circuited.

The closed-coil type of winding may be used on either a ring or a drum armature. Fig. 3 shows a simple closed-coil ring armature winding. This differs from the open-coil type in that a continuous circuit exists through the entire winding, none of the coils being open-circuited.

As previously mentioned, there are two general classes of closed-coil armatures—the ring type and the drum type. The principle of operation is the same for both, but the arrangement of the windings is different. The ring armature is, in general, the more simple and easier to understand than the drum. It consists essentially of a coil or series of coils of wire or other form of conductor wound in a single direction about a laminated iron ring and connected at regular intervals, by taps, to a series of commutator segments, as shown in Fig. 4. The winding shown in the illustration is for a bipolar machine. By the application of the thumb and finger rule, shown in Fig. 1, it will be seen that the currents in the two halves of the winding flow in opposite directions, their points of bifurcation being at the positive and negative brushes, as shown. The closed-coil ring armature is no longer in general use except on some small motors.

The drum armature is now used almost exclusively for general service. Its winding being, in general, of the closed-coil type, an unbroken path can be traced from any point in the winding, through all the conductors and back to the starting point. Fig. 5 illustrates the connections for a bipolar winding. They are as follows: 1-10-3-12-5-14-7-16-9-18-11-20-13-2-15-4-17-6-19-8-1. Fig. 6 shows the winding of Fig. 5 developed on a flat surface.

The individual conductors are otherwise designated as elements, while that part of the winding connecting any commutator segment directly through two elements to another segment, as shown by the heavy lines in Figs. 5 and 6, is known as a coil. Sometimes a coil, instead of consisting of one turn, as shown in the figures, will make several turns around the same chord of the armature circumference before connecting with its two commutator segments. In this case the two collective sides of the coil parallel to the shaft are treated in the winding diagram as single bars or elements in the same manner as in the coil of one turn.

It will be seen in Figs. 5 and 6 that the same number of winding spaces is included between the two elements of every coil. This is known as the pitch of the winding. In the two figures under consideration it is equal to 9.

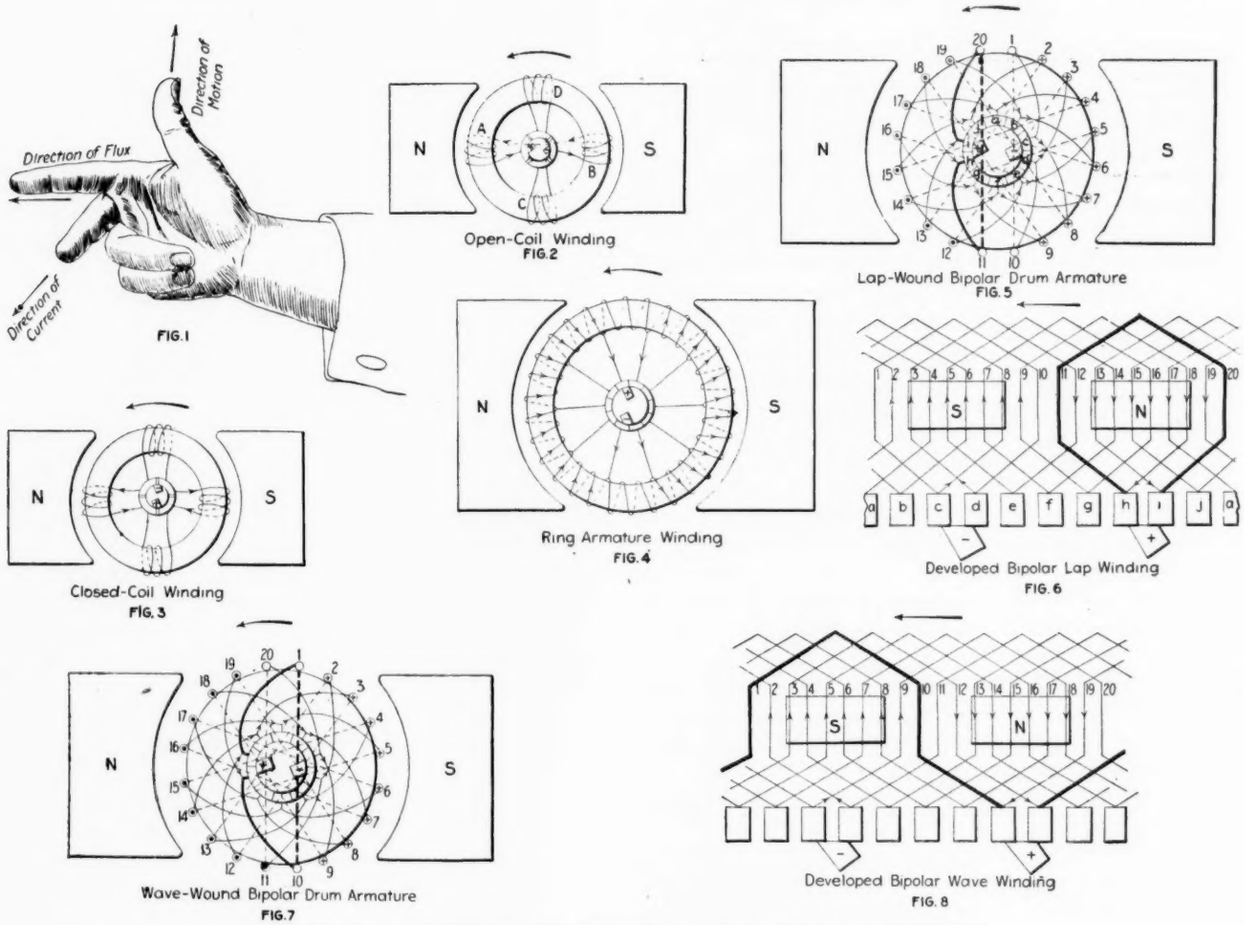
The fundamental formula for the determination of the pitch for any closed-coil armature is as follows:

$$Pitch = \frac{1}{M_p}\left(\frac{C_n}{C_s} \pm m\right)$$

in which

M_p = Number of pairs of field poles;
C_n = Total number of conductors on armature;
C_s = Number of conductors per coil;
m = Number of parallel paths of current through armature.

type of winding, and the dividing points being always at one or more pairs of brushes. The distribution in a bipolar lap-wound drum armature is shown in Fig. 5. By the application of the thumb-and-finger rule, the direction of current flow is found to be as indicated by the arrows. It will be observed that the current divides into two branches at the brushes, each branch comprising half the winding. Furthermore, it will be seen that the two respective commutator segments to which each coil is connected pass under the brushes twice every revolution and are thus short-circuited. This is a necessary feature in the action of the armature, as will be shown in the next article of this series. By commutation is meant the changing in direction of the currents in the coils short-circuited at the brushes. In every coil



FIGS. 1 TO 8. ILLUSTRATING PRINCIPLES AND TYPES OF WINDING

In Figs. 5 and 6, as the winding advances from element to element, it moves forward to the extent of the pitch and then loops backward, alternating in this manner around the armature. The designation of "lap," or "parallel," winding is applied to this method of connecting the conductors.

Figs. 7 and 8 show a different method of winding. The connections, instead of alternately looping backward, move continually forward. This winding is known as the "wave," or "series," type.

The two general schemes of winding having been considered, the distribution of current can now be analyzed. In every closed-coil direct-current armature there must be two or more parallel branches of the current, the number depending upon the number of poles and the this takes place as many times during each revolution as there are brushes.

In analyzing the action of the currents at commutation, consider the bipolar winding shown in Fig. 9. As a coil approaches a brush, it is carrying half of the total armature current. Consider the coil shown by the heavy lines. When the segment h has passed from under the brush, the current will flow through the coil in a direction opposite to that before the coil reached the brush. It is thus apparent that a complete reversal or commutation of current has taken place in the coil.

For satisfactory results commutation should take place at such a position in the field that the current flowing through the coil prior to contact with the brush will, as the coil passes under the brush, die away. A current in

the opposite direction is then built up to a value such that it is of approximately the same strength as the current in the other half of the winding, so that as the coil leaves the brush and again becomes active, it does not suffer a sudden influx of current. Owing to the element of self-induction, or electrical inertia, in a coil, a current cannot be sent through it at once, but on the contrary, the current will rise gradually. It therefore follows that if a current is not already flowing in the coil as it leaves the brush, a sudden passage through it of the working current from the other half of the winding will be opposed by the self-induction of the coil, with the result that the current, having no other path to take, will

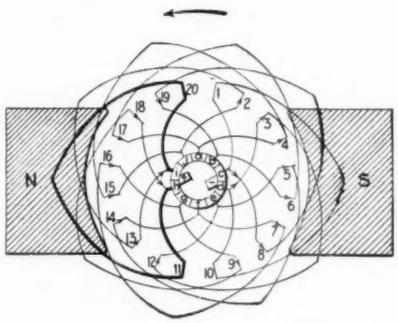


FIG. 9. BIPOLAR LAP WINDING

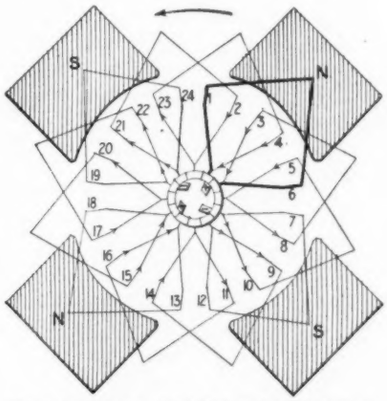


FIG. 10. FOUR-POLE LAP WINDING

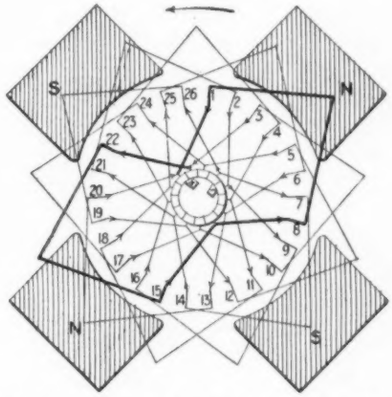


FIG. 11. FOUR-POLE WAVE WINDING

arc over from segment *h* to the brush. This condition, however, is easily remedied. If the brush is given a slight lead ahead of the neutral axis, or line passing through the point of zero e.m.f., the point of commutation will be advanced to a position such that the current in the short-circuited coil will be built up to the proper strength before the segment *h* leaves the brush. As a result, the coil is prepared to take the working current as soon as it leaves the brush and the arcing over or sparking will thus be avoided.

Were the brush given a backward lead instead of forward, the sparking would be worse than with the position of no lead at all. This is because the current will still flow through the coil, upon leaving the brush, in the same direction as previously. The current in the other half of the winding will therefore not only arc over, but sparking will also ensue from segment *h* to the brush as a result of opening the path of the short-circuit current in the coil. The sparking will be the combined effect of the arcing over of two currents, whereas with the forward lead only one current will be involved.

In multi-polar machines the number of poles must be divisible by two, and either the lap or wave form of winding may be used. If of the former type, there will be as many branches of current as there are poles and the same number of brushes is generally used. With the latter there are only two branches of current irrespective of the number of poles, hence only two brushes are needed, although in larger machines more are used. Fig. 10 shows a four-pole lap winding and Fig. 11 a four-pole wave winding.

Sometimes, instead of having a single closed-coil winding, it is desirable to have two or more. The designation of simplex, duplex, triplex or multiplex is applied according as the winding as a whole is composed of one, two, three, or more component windings. The respective windings are entirely independent of one another; in fact, with a duplex winding, two commutators might be used, one at each end of the armature. Where but one commutator is used, the segments connected to the respective windings are alternately interspaced. In the latter case the brushes must be thick enough to cover an area of commutator sufficient to collect from all the windings simultaneously.

In the diagrams shown herewith, only a few conductors are used for the sake of clearness. However, in practice, the number runs into the hundreds. If these were placed in a single layer, the armature would have to be of excessive circumference to provide the necessary space. This difficulty is avoided by using two or more layers. The same general scheme of connection is followed as with the single layer. To secure the requisite mechanical stability and at the same time to reduce the air gap to a minimum, the conductors are carried in radial slots cut in the armature core. This arrangement not only affords the advantages mentioned, but it provides more ample protection for the coils. It is furthermore much easier to wind the armature when the coils are placed in slots.

The number of commutator segments can be varied within certain limits, but is generally such that the difference of potential between any two consecutive segments will at no time rise above fifteen volts, and it is preferably kept somewhat below this limit. Various methods and rules are followed in armature winding, depending upon the service for which the machine is designed and upon the tastes of the manufacturer. However, it can be said that, in general, to secure the most efficient results, perfect symmetry is imperative so that the various sections may be as nearly equal as possible in both resistance and inductance.

In Calculating the Water Required to Condense Steam the temperature of the steam must not be assumed to be that due to the terminal pressure, because it may be considerably superheated by any one or all of three conditions: (1) By contact with cylinder walls or other surfaces that have been in contact with steam at a higher pressure and temperature, an unavoidable condition in the reciprocating type of engine. (2) Free expansion of the steam without doing work; the difference between the pressure in the cylinder as the exhaust valve opens and the final condenser pressure is sometimes great—in a direct-acting pump it may even range from full boiler pressure to that of the vacuum. (3) Friction of the steam and particles of water in the passages to and in the condenser may amount to considerable. All of the foregoing conditions call for a greater amount of condensing water.

Inter-Boiler Inspection

By J. C. Hawkins

SYNOPSIS—To improve the economy of operation and to anticipate repairs it will pay to inspect the boilers between visits of the state or insurance inspector. An outline of procedure is presented.

There are many boiler plants in which the duty of examining the boilers at regular intervals is left entirely to the state or insurance inspector. The engineer in many cases considers that after the insurance inspector has gone over and examined them no other inspection is necessary. This is probably true in so far as safety is concerned, although a frequent inspection by those in close touch may discover faults or gradual deterioration that would not be noticed by the stranger. It is not within the province of the inspector to determine whether the boiler is in proper condition to produce steam economically. The engineer should make it a point to don a suit of overalls when the inspector arrives and go over the work with him, discussing any points that may come up. This will not only help the specialist in the examination of the boilers, but will be of advantage to the engineer as well. Make the engineer a confidant in any changes that have been made or that are contemplated, and whether his advice is accepted or not it will do no harm to know what he thinks of the proposition.

There are many things that the engineer should watch for that are of only passing importance to the safety inspector, and for this reason the chief engineer or boiler superintendent should give the boilers a thorough examination both internally and externally at stated periods, not only for safety, but for economical operation, close records of their action and for the anticipation of future repairs.

If the boilers are to be inspected at frequent intervals, it is advisable to have made especially for the purpose a one-piece suit similar to that used by the boiler inspector. A few tools are needed, such as an electric light with a guard on a long extension cord, and a small cross-peen hammer made extra long, with the peen sharp enough to chip off scale or burned ashes. Other essentials are a notebook and pencil. If the examination is the first given the boiler by the engineer, a scale and pair of calipers should be included so that the dimensions of all parts may be taken and placed on the report for future reference.

Inspecting Water-Tube Boilers

On a water-tube boiler it has been the practice of the writer to proceed with the examination in the following manner; on other boilers the same procedure is carried out as nearly as is practical: After putting on the inspection suit, go in on the grates with the tools. First notice whether there are any bags or blisters on the tubes, observing the relative location and size of any defect. See whether there is any evidence of leakage around the ends of the tubes or the front stay-bolts; and if a leak is found make a note of it in the book, stating the number and row for future reference. Examine the bridge-wall and furnace brick. If any repairs are needed, jot it down. Then examine the front baffle wall by holding the light above the head and looking between the rows of tubes diagonally. A leak through the baffle will affect the economy of the boiler, as part of the heating surface will be bypassed. At the most distant points from the soot blower the space between the tubes frequently will be filled with fine ashes. Insulation of the tubes in this manner should not be permitted. Examine the grates or stoker if there is one, noticing the condition of the bars, plates and air spaces.

Next, go in above the tubes under the front end of the drum and look for bags on the bottom of the drum, also for leaking rivets and stay-bolts. Tap them and the tubes with the hammer. Hold the light so that it will shine between the tubes and examine the baffle walls from the top. Also look at the brickwork around the drum and the partition between the first and second pass, as leakage here will also reduce the economy of the boiler. Make notes of all defects seen.

In the Combustion Chamber

The next place to inspect is the combustion chamber. See that no ashes are lodged between the tubes, and examine the rear stay-bolts and tube ends for leakage. Make a note of any tube end or stay-bolt found defective. There is little probability of finding a bag. Examine the blowoff pipe for leakage and external corrosion. Rap it hard with the hammer, noticing whether it sounds solid and in good condition. Particular attention should be paid to the blowoff pipe, as it is liable to external corrosion from the action of moisture and acids in the soot, especially at the edge of the brickwork and in the threads. Examine the nipples between the rear header and mud drum. Clean away the scale and ashes with the hammer and look for external corrosion or leakage quite likely to be found at this point. Inspect the rear baffles and brickwork.

Go in above the tubes at the rear end, see that they are properly cleaned, look at the stay-bolt ends, rivets and tube ends for leakage and examine the baffle walls. Watch the action of the damper, while the helper opens and closes it, to see that it opens wide or closes tight when the lever on the outside indicates these positions. Sometimes the gear may slip, and the damper will be only partly open when the lever indicates that it is wide open. See that the breeching is not filled with ashes and soot.

On the outside walls of the setting look for cracks, especially around the doors, and see that the doors shut tight. Air leaks may be found by going over the walls with a candle, or while the boiler is in operation by closing the damper nearly tight and throwing in a shovelful of fine coal. The smoke will pour out through all the cracks and crevices through which air may be drawn in with the damper open. These places should be marked; and after the repairs have been made, examine again to see that the work has been done properly.

Next, examine the top of the boiler for cracks in the setting and for leaking pipe joints, flanges or stuffing-boxes. The safety valve and the blowoff valve should be watched for leakage while the boiler is in operation. If they have been leaking, now is the time to see that the

repairs are properly made. Examine the water-column floats, the piping, feed-water regulator (especially the valve and diaphragm), feed valves, check valves and gage cocks. See that the water-column blowoff pipe and valves are in good order and that the valve seats are not cut or the packing worn out. This finishes the external surfaces of the boiler; and when several boilers are to be examined, it is best to go over all of them externally, making notes on each boiler separately, before going inside, as that finishes the most disagreeable part.

TABLE 1. ENGINEER'S INSPECTION REPORT

Date.....191 . Boiler No..... Inspected by.....

EXTERNAL

Furnace:
- Brickwork
- Baffles
- Tubes
- Stay-bolts
- Grates
- Stoker

Above the tubes:
- Baffles
- Shell
- Tubes

Combustion chamber
Superheater
Blowoff Pipe:
- Surface
- Bottom

Feed pipe
Valves
Regulator
Gage cocks
Water column
Floats
Steam gage
Safety valve
Outside Walls:
- Sides
- Front
- Back
- Top

Main stop and non-return valves

INTERNAL

Shell and Drum:
- Feed pipe
- Mud pan
- Steam and water outlets
- Scale, pitting, corrosion
- Braces
- Dry pipe

Tubes:
- Scale, pitting, etc
- Stays
- Handhole plates

Fusible plug
Miscellaneous

(ON BACK OF INSPECTION REPORT)

Repairs made since last inspection.....Cost of repairs $.....

Repairs needed at next shutdown.....Estimated cost $.....

Remarks, sketches of pitting and other matter not fully treated above.....

In making the internal inspection the writer goes inside the drum first and looks for signs of pitting, especially along the water line, and for signs of scale or corrosion in all parts of the drum. Each item should be mentioned in the notebook. Knock off some of the scale to learn its thickness and composition and to determine how easily it comes off. Also measure the depth of any pitted spots, making a rough sketch of them and their location with such other data as will be essential in making a clear report. These data should be referred to in making the next examination to determine whether the trouble is getting worse. Tap the braces with a hammer to see if all are tight, and examine the mud pan and internal feed pipe to see if they are clear. Sometimes the internal feed pipe may be found nearly stopped up with scale, which may prevent sufficient water from getting into the boiler, or it may be loose in the head, allowing the cold water to discharge directly into the rising steam bubbles from the front header. See that the dry pipe is in its proper position and that the holes are clear. Sometimes this pipe becomes turned so that the steam holes are on the bottom side instead of the top, which of course defeats the purpose of the pipe. Examine the connections to the water column and steam gage. Take plenty of time in here, and nothing should be overlooked.

Next come the stay-bolts and tubes in the water leg or header. Have a helper hold a light at the front end of each tube; or if all the caps have not been removed, take off a few at random and look through the openings to see if there is any scale and to determine the general condition of the metal. Sometimes a pile of loose scale will be found in a tube through which a turbine cleaner has recently passed. Unless removed, this scale might lodge in the tube and cause a bag. Reach into the header with the hammer and tap the stay-bolts to see if they are tight. Examine the tube cap joints, noticing whether old gaskets are sticking to them or whether they are badly sprung. Proceed in the same manner on the opposite end.

This covers the boiler inside and out and includes items that would not attract the attention of the insurance inspector. If the tubes are found dirty either inside or outside, some better method of cleaning them or preventing them from getting in this condition may suggest itself to the engineer while making the inspection. Likewise, cracks in the setting or around the doors may suggest a remedy whereby the percentage of CO_2 will be increased, and any needed repairs that have been overlooked may be found and attended to before the boiler is put into operation.

TABLE 2. DATA ON BOILERS

Make of boiler
Serial No. Plant No.
Date installed
Allowed pressure lb.
Working pressure lb.
Safety valve set at lb.
Area of grates sq.ft.
Dist. from grate to tubes ft.
Type grates
Ratio G.S. to H.S.
No. size of bars
Height of bridge-wall ft.
Heating surface sq.ft.
Tubes Shell
Superheater Total
Diam. tubes Length
No. Thickness
Shell of Drum:
Diameter Length
Thickness Joint
Head thickness
Braces, No.
Type Size
Steam nozzle, diam. in.
Feed-water regulator, made by
Size Serial No.
Gage cocks and glass, fittings made by
Size
Firebrick in furnace front wall
One side Bridge-wall
Baffle first Second
Kind of brick
Special brick, if any
No. of common brick in walls
Floor area sq.ft. x
Height of boiler nozzle

Height of walls
Distance from top of boiler to ceiling
from nozzle ft.
Space between batteries ft.
In front ft.; back ft.
Size of breeching
Dimensions of flange O. D.
I. D. Bolts B.C.
Safety valve, name
Size Type
Serial number
Blowoff valve, name
Size
Make steam gage
Size in.
Serial No.
Make soot blower
Serial No.
Dimensions
Damper regulator
Serial No.
Steam-flow meter
Serial No. Size
Type
Dimensions of stack
Weight of boiler only lb.
Total weight lb.
Costs:
- Boiler $
- Foundation
- Setting
- Stoker or grates
- Erecting
- Chimney complete
- Accessories

Total cost complete $

Remarks.....

Engineer

After the inspection is completed, the steam gages should be taken down and calibrated and all adjusted to read properly. Sometimes a test gage is connected to the same line and the adjustments made without removing the gage. The former way is the best. If a gage tester is not at hand, the gages may be connected to a pressure line on which there is a gage known to be correct or one that is kept for testing purposes only. It is important that all gages on the several boilers read alike, because it is dangerous to cut in a boiler on the line when the pressures are not equal.

If the safety valves have been repaired or reground, they will have to be reset, especially if of the spring loaded type, after the boiler is fired up. This should be

done by a responsible man, and an accurate gage should be used to set the safety valve by.

A report should be made of the conditions found, while they are fresh in mind. The value of this report as a reference will depend entirely on its completeness. Some of the things to be looked for in the inspection may seem unimportant at the time, but they should not be slighted. This report should make it possible to compare the condition of the boiler at any time with its condition at former inspections. It should also indicate any repairs that are likely to be needed at the next shutdown, so that the material may be ordered ahead and will be on hand when wanted to prevent unnecessary delay.

On the first inspection all dimensions of the boiler and setting should be made for future reference. This need not be done at subsequent examinations unless there is some good reason for it. If properly taken, these dimensions may be used in ordering spare parts or supplies.

As described, the inspection here applies to a horizontal water-tube boiler, but the same procedure, in so far as it can be followed, may be used on any boiler. An inspection of this kind every three to six months will keep the man in charge thoroughly familiar with the existing conditions of each and every part of the boiler. It is a dirty undesirable job, but it will make the engineer's work easier in the end, help to keep the efficiency of the plant at its highest point, because poor conditions in the boilers are not as readily noticed as in other parts of the plant, and prepare the engineer to meet emergency breakdowns by having the necessary spare parts on hand or by making repairs before the breakdown occurs. The records should be made of uniform size, so that they may be filed easily. No set form that would be suitable for all plants can be suggested here, but each engineer will be able to design the kind of record that seems to apply best to his conditions; and if it is complete, it will give a detailed account of the boilers, especially if the repairs made between inspections and the cost figures are entered.

Power-Plant Magazines

By A. J. Dixon

Perhaps it is needless to remind anyone interested that to be rated as a first-class operating engineer a man must be a consistent reader of the best periodical on engineering literature—not a reader merely, but a close analytical student of much that he will find in his engineering magazine as well. For the average engineer such concentration upon the literature of his trade naturally narrows the opportunity of becoming what the world calls a man of broad culture, because of the difficulty of crowding the great diversity of reading which a wide range of culture demands into the hours available.

Nevertheless, the field of operative engineering is so vast and diverse in its technical aspects that it possesses a culture peculiarly its own—a culture that will stamp as a man of superior intellectual worth anyone who will sedulously follow up the progress of engineering invention and discovery and the scientific investigation upon which it rests.

Some engineers are, indeed, so keen to grasp all that this field of culture has to offer that they read everything in the paper from cover to cover, advertisements and all. Such men, besides enjoying the prestige and personal satisfaction that an encyclopædic knowledge of current theory and practice brings to them, are always the ones who skim the cream of the profession in the way of position and emolument. Favoritism, prejudice or jealousy cannot hold them back. They are bound to win, because with equal opportunity in other respects, the close student is the best-equipped man for any kind of a job above the grade of sheer manual labor. He holds an advantage that nothing else can overcome.

Engineering journals are read with two main purposes in view—to post up on current topics and to acquire information for present use, or to accumulate a store of knowledge that may be drawn upon for future service. Of course a man gets some entertainment out of his reading. Here and there he expects to find an item that will season his precise professional reading with the spice of diversion. A touch of real humor now and then is appreciated. But mainly, an engineer's reading of his trade paper has a utilitarian purpose.

A Practical Education from Engineering Magazine

Reading and research in an effort to dig out information that will aid in meeting the exigencies of a passing problem in operative engineering is one of the very best means for acquiring a practical education; that is, if a man is persistently bent upon learning all that the available literature has to offer on the particular questions that bother him. The high-class engineering magazine is a veritable treasure mine for an engineer seeking knowledge in this way. He gathers an item here and another there. He gets into the paper with an explanation of his difficulty, and immediately his problem becomes the center of a symposium of advice and comment. He gleans a morsel of information from this week's issue, more from next week's, and many more from those that follow, and in correlating, arranging and fitting together the accumulated facts he grinds the minutiæ of that particular class of problems indelibly into his consciousness.

The interest that many ambitious engineers manifest in their work has a trend or bias toward some special feature of it. When his engineering paper arrives, the first care of a man so inclined is, naturally, to explore its pages in search of something touching upon the subject of foremost interest to him. Thus his scrutiny of the paper fulfills one of the main purposes of reading—the acquisition of knowledge to fit a present need or line of investigation. But if his interest in the paper extends no further than this—if, after scanning its pages for information relating to his specialty and failing to find any, he tosses the paper aside and leaves it thereafter untouched—he does himself a big injustice, for he is simply trailing in the wake of that much-handicapped individual, the one-groove engineer.

Everything of a strictly technical and practical character that his engineering paper contains is proper intellectual fodder for the operating man. There may be articles dealing with branches of engineering science that hold no present interest for him and, lacking incentive, to read them might be a tax on his patience and capacity for concentration. But he should supply an incentive. He should muster his mental forces and read such articles through as attentively as he does those that wind around the theme of special interest for him, remembering that the chances are often many times better than even that from such articles he will acquire ideas that will prove invaluable to him in his future practice.

Every persevering reader of power-plant literature appreciates this fact. Scarcely an article is printed that does not contain at least one item of practical information —one wholesome suggestion that might serve as a sure guide, may be many months in the future, when the engineer would otherwise be stumped to find a way out of some dilemma. These bits of practical knowledge are like the seemingly worthless accumulation of odds and ends that the prudent man will often store away against an always possible moment of need; useless junk to all intents and purposes until a situation develops wherein some article in the collection suddenly assumes an aspect of indispensable utility. Nearly every engineer has had this experience. Many a man has extricated himself from a difficulty by intuitively remembering some kink or idea which he found in his paper months before and to retain which seemed, at the time, only a profitless cluttering up of memory's processes.

Operative steam engineering is prolific of unexpected and puzzling situations. An engineer is never sure from day to day that some irregularity will not happen to baffle his skill and tangle him up in his effort to rectify it. The man who stores up the most information for future use is the one who is least likely to meet with discomfiture at such times.

The advertisements are a powerful aid in this respect. Nearly every advertisement that one sees in his engineering magazine contains a concise lesson in some branch of engineering. In the advertising pages the engineer finds the merits of every dependable appliance or device more or less briefly epitomized. He will see apparatus listed therein for which he may have no immediate, and as it may seem, no prospective use. But as already remarked, unexpected events constantly confront us, and conditions in the plant may at any time so shape themselves as to call for the application of some piece of advertised equipment hitherto deemed unnecessary.

That engineer is grossly remiss to himself who does not use the means that the advertising pages of the paper offer for keeping in step with the progress of engineering invention. Scarcely in any other bread-winning occupation could a man manifest such laxity and still keep afloat.

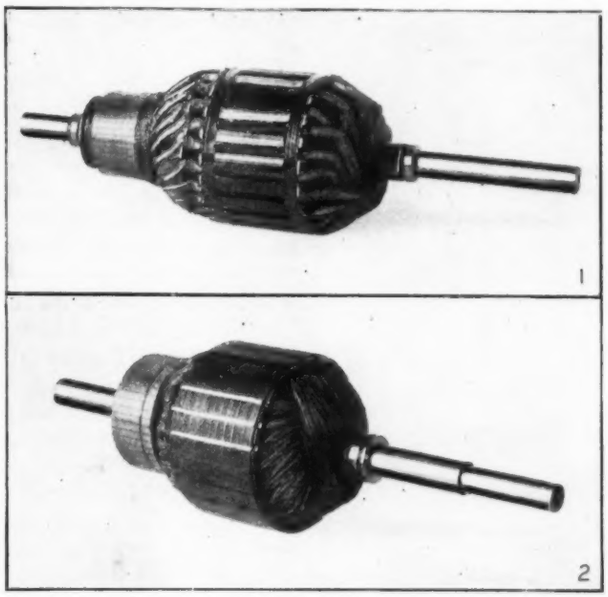
Electrical-Machine Shafts

By Paul Justus

In some of the early types, electrical-machinery builders constructed the armatures of their motors and generators with shafts the same diameter through the bearing and pulley, as in Fig. 1. When the bearing on the pulley end wears out or gets hot, so that it is necessary to renew it, with hardly an exception the shaft will have to be turned down.

The bearings on all small-size machines are solid bushings, not split, and have to be put on over the end of the shaft. Therefore, the shaft must be turned down for the full length from the armature out, the bearings rebabbitted and bored to the new diameter, or new ones made. This makes the shaft too small for the pulley. Consequently, it is necessary to bore out the pulley and fit it with a bushing. On the other hand, if the shaft passing through the pulley had been turned down to a smaller diameter than the part in the bearing, like Fig. 2, the bearing surface could be smoothed up a good many times before it would be reduced to the same diameter as the section through the pulley. A bushing in a pulley is likely to work loose and give trouble if the job is not properly done. Of course, on the larger motors where the bearing shells are split, the part of the shaft in the bearing only has to be trued up.

In bushing the pulley it is a good idea to turn the end of the shaft through the pulley to a smaller diameter



FIGS. 1 AND 2. SHOW CORRECT AND WRONG DESIGN FOR PULLEY END OF ARMATURE SHAFT

than that through the bearing. Then if the shaft comes back a second time, the bearing only has to be taken care of.

A good point to consider when selecting electrical machines is the ease with which repairs can be made. This attention should not be confined to the design of the machine alone, but should be given also to the place in which the machine is to be installed.

Measurements of Discharge of Pumping Engines by Means of Nozzles ("Transactions" A. S. M. E. Volume XII). The measurement of water by computation from its discharge through orifices or through the nozzles of fire hose furnishes a means of determining the quantity of water delivered by a pumping engine, which can be applied without much difficulty. John R. Freeman ("Transactions" A. S. M. E., November, 1889) describes a series of experiments covering a wide range of pressures and sizes, and the results show that the coefficient of discharge for a smooth nozzle of ordinary good form was within ½ per cent., either way, of 0.977, the diameter of the nozzle being accurately calipered and the pressure being determined by an accurate gage attached to a suitable piezometer at the base of the play-pipe. To use this method for determining the quantity of water discharged by a pumping engine, it would be necessary to provide a pressure-box to which the water would be conducted and attach to the box as many nozzles as would be required to carry off the water. According to Mr. Freeman's estimate, four 1½-in. nozzles thus connected, with a pressure of 80 lb. per sq.in., would discharge the full capacity of a 2½-million gallon engine. He also suggests the use of a portable apparatus with a single opening for discharge, consisting essentially of a Siamese nozzle, so called, the water being carried to it by three or more lines of fire hose. To insure reliability for these measurements, it is necessary that the shutoff valves in the forcet main, or the several shutoff valves, should be tight, so that all the water discharged by the engine may pass through the nozzles.—National Tube Company.

A Little Good Oil in the Right Place is better than a whole lot elsewhere.

Beyer Barometric Condenser

A counter-current barometric condenser (Fig. 1) is being turned out by the Ingersoll-Rand Co., New York City, in which air and water flow in opposite directions (Fig. 2). The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air-removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle plates assisting the water to absorb to its full capacity the latent heat of the steam. The noncondensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. Ample opportunity is given for the removal of the air content of the water before it mixes with the steam. This not only facilitates the mixing process, but permits the removal of air and vapor at a comparatively low temperature—a distinct advantage, as the reduced volume saves in vacuum pumpage power. The steam inlet is of large diameter to secure low velocity, and is hooded in such a way as to discharge the steam into the center of the condensing vessel. The air-removal opening is also of ample area and is protected by a self-draining baffle and trap. This prevents water being carried over into the vacuum pump. The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser.

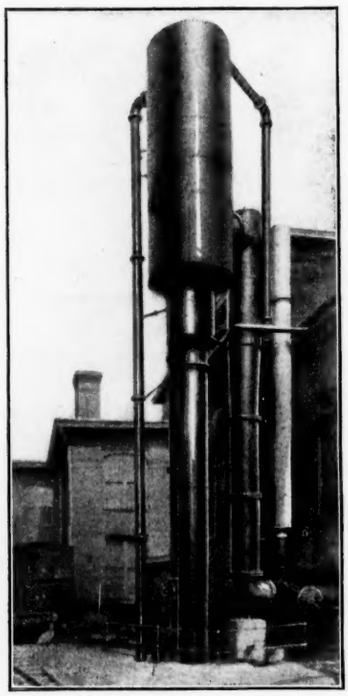


FIG. 1. EXTERNAL VIEW OF CONDENSER

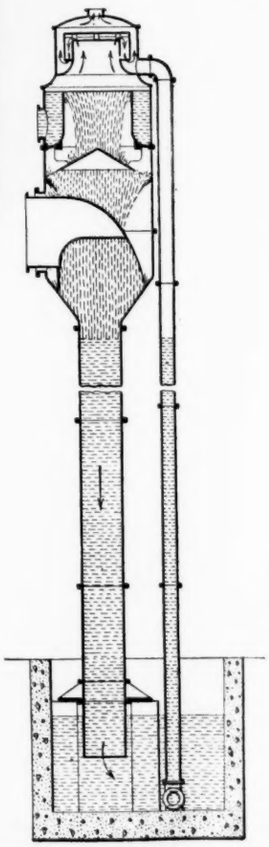


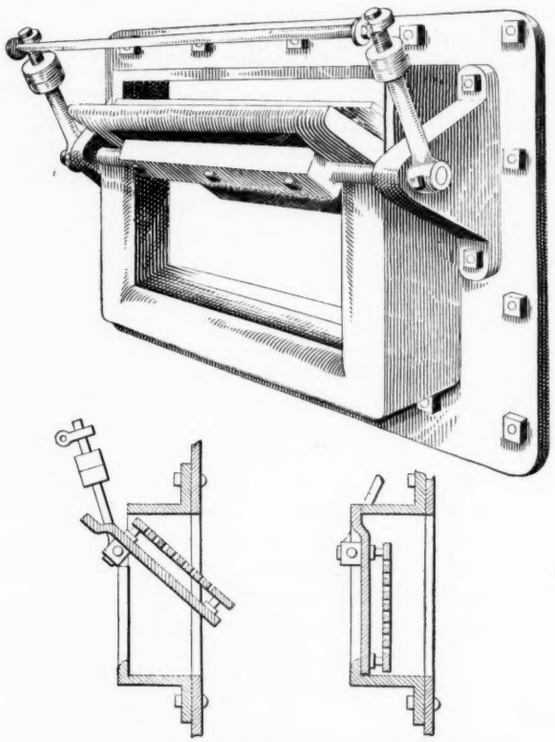
FIG. 2. SECTION THROUGH CONDENSER

When a water pump is required to elevate cooling water to the condenser head, pumps are provided, either reciprocating or centrifugal, as desired. Where the level of the cold well is of sufficient height above the hot well, the condenser will lift its own cooling water, dispensing with a water pump.

As the vacuum and water pumps are independently operated, they can be regulated to suit varying water temperatures and conditions, and the plant, in addition to its efficiency in general service, is adapted for duty as a central condensing unit serving a number of prime movers.

Watkins Furnace Door

When a return-tubular boiler ruptures, it makes no difference whether the furnace doors are blown open or not, as the boiler room is generally wrecked and the fireman killed. When a water-tube boiler ruptures, it generally occurs in a tube, and under such circumstances it does make a difference as to whether the furnace doors are blown open. If some style of furnace door is used that cannot be blown open, the chances are that the fireman will escape with but slight injury in case a tube does burst. Among the several sorts of safety furnace doors that have been designed is the Watkins, illustrated herewith and patented by C. W. Watkins, 146 Sharpe St., Dorranceton, Penn.



DETAILS OF WATKINS FURNACE DOOR

One of the essential features of the door is a frame that is secured to the boiler front. This frame supports two brackets in which the furnace door swings by means of a pivot rod that is secured to the door at a point above the center line. On the outer ends of the pivot rod are arms fitted with adjustable weights to counterbalance the weight of the door. A cross-rod connects the weight arms at the top and is for convenience in opening and closing the door. The illustration shows a front and also side views of the door in closed and open position.

Normally the door is held in a closed position by gravity. When it is opened for firing, the handle bar is

pulled down and the door is opened inwardly, the counterweights holding it in an open position.

Should a boiler tube burst, the door is forced tightly to its closed position and is prevented from being blown open by the top and bottom edges that face against the frame at the top and against the projecting edge at the bottom, thus preventing any material escape of water, steam or live coals through the furnace-door opening.

Solderless Connectors

Soldered connections in electric cables, when properly made, are strong mechanically and possess high conductivity, but it requires no small amount of experience and care on the part of the workmen to make a soldered connection with these qualities. Not only is considerable

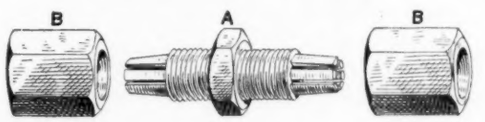


FIG. 1

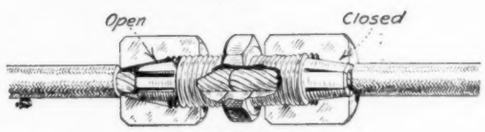


FIG. 2

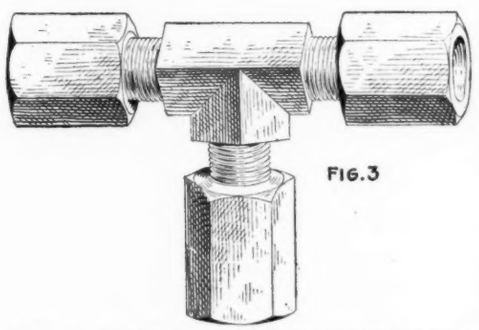


FIG. 3

FIGS. 1 TO 3. SHOW THE CONSTRUCTION OF FRANKEL SOLDERLESS CONNECTORS

time necessary, but always the use of some sort of heating device, which, at the best, creates a fire hazard. Furthermore, if a soldered connection becomes overheated the solder will flow out, and cables have been known to fall out of the lugs that connected them to the terminals of switches, etc., from this cause. To take the connection down always requires a heating device and considerable time, and if the connection is a splice in a large cable it is doubtful if it can be put up again without cutting the cable back of the splice. In many cases this cannot be conveniently done.

To provide a means whereby connections can be readily made in electric cables without the use of any heating device and with only the ordinary tools carried by an electrician, the Frankel Connector Co., 177 Hudson St., New York City, has developed a line of solderless connectors. Fig. 1 shows the part of one of these connectors used for making a straight connection in a cable.

The phantom view (Fig. 2) shows the principles of the connector and how the design permits the use of as few parts as possible to make a rigid connection. This simple construction reduces the liability of the connector's getting out of order and in addition provides a connection that is strong mechanically and electrically. Fig. 3 illustrates the type used for making a branch splice. The company also manufactures a complete line of connectors for panel boards to replace soldered terminal plugs for front and back connections.

By using solderless connectors in place of soldered ones there is a substantial saving of time as well as the added advantage of providing a joint that can be broken down quickly without harm to the cable.

In the report containing the approval of the Frankel "Solderless Connector" the Underwriters' Laboratories, Inc., states, regarding a test: "At 1,000 amp. the soldered joint melted and dropped from the joint. The joints where the wires were attached to the solderless connectors were unaffected by the test."

Corrosion of Steel Stacks

By R. K. Long

Steel stacks corrode on the interior and exterior surfaces. Corrosion occurring on the inside is likely to be more serious and rapid than corrosion taking place on the outside, for the latter is easily detected and may be prevented by the application of two or three coats of suitable paint after the surface is carefully prepared. The painting must be done when the stack is erected and should be repeated at frequent intervals to keep it in good condition, otherwise the elements and the sulphur fumes, etc., from the furnace will soon start corrosion.

To prevent corrosion on the inside of the stack is a less simple and more costly matter, because the effect of the hot flue gases—which contain sulphurous acid and carbon dioxide, which are corrosive in the presence of moisture—have to be contended with. In this case the remedy is to line the stack with firebrick and at the same time fill the intervening space between the steel and brickwork with a grouting of cement. This grouting should be done carefully, otherwise trouble will develop and progress rapidly. This lining of brick should go to the full height of the stack, because it has been found that the upper rings of the stack corrode faster than the lower, the probable explanation being that the condensation is greater at the top than at the bottom.

One of the factors tending to cause the interior deterioration of steel stacks, especially those that are unlined, is having them out of service, even for short periods. Once a stack is in commission, therefore, it should remain in commission, although the load be light. Another fact that practical experience has proved is that an unlined stack serving fires that are frequently banked corrodes faster than one serving fires that are seldom banked, although the latter may be using the same fuel and be subjected to the same atmospheric conditions; that because, as has already been mentioned, corrosion to a large extent is due to the sulphurous acid and moisture forming sulphuric acid, and to carbon dioxide. While a fire that is banked does not give off as much sulphurous acid or carbon dioxide as a fire that is active, the lower temperatures and the greater moisture content are more favorable to corrosive action.

It is advisable to use brick or cement stacks where a chimney is to be in service intermittently. If steel stacks are used, they should by all means be lined, as lining lengthens their life and materially reduces the radiation losses through the metallic walls, in this way improving the draft.

Calculating the Dimension of Chimneys and Stacks*

By George A. Orrok†

SYNOPSIS—Presents the calculations involved in determining the proper dimensions for securing stability in brick chimneys and steel stacks.

The following group of formulas enable one to determine the thickness of brickwork necessary for stability at any point in the chimney.

Let

P = Wind pressure, pounds per square feet;
D = Diameter (outside) at base or at the given section;
d = Diameter (outside) at top, both in feet;
H = Height in feet above the section;
B = Mean thickness of shell in feet;
W = Weight of stack above section, in pounds;
a = Area of shell plate in square inches;
t = Thickness of shell plate in inches;
r = Inner radius of shell in inches;
p = Load per square inch of shell;
M_o = Overturning moment;
M_r = Resisting moment;
115 = Weight of cubic feet of brickwork.

The general formula for stability $M_o < M_r$ must always apply.

For brick stacks following Rankine:

	Square Stacks	Tapering Round Stacks	Straight Round Stacks
$M_o =$	$\frac{PH^2(D+2d)}{6}$	$\frac{PH^2(D+2d)}{12}$	$\frac{PH^2D}{4}$
$M_r =$	$\frac{WD}{3}$	$\frac{WD}{4}$	$\frac{WD}{4}$
$W =$	$460\,BH\frac{D+d}{2}$	$361\,BH\frac{D+d}{2}$	$361\,BHD$
$B =$	$\frac{PH(D+2d)}{400\,D(D+d)}$	$\frac{PH(D+2d)}{541\,D(D+d)}$	$\frac{PH}{361\,D}$

By solving for P, the pressure of the wind necessary to just remove the strain from the joints on the weather side may be found. The joints on the neutral axis will be strained to the amount due to the weight above them and the joints on the leeward side to twice this amount. The crushing strain on the leeward side should not exceed 170 lb. per sq.in. for good brick laid in cement mortar or 100 lb. per sq.in. if lime mortar is used, neither should it exceed $(70 + 0.65H)$ lb. per sq.in.

The base of a brick stack should rarely be less than one-tenth of the height. The allowable batter according to different authorities varies from 1 in 192 to 1 in 20 on each side, but the best practice lies between 1 in 30 and 1 in 40 for ordinary brick, with 1 in 60 to 1 in 80 for the Custodis or hollow-tile method of construction.

For steel stacks, whether lined or unlined, the following formulas are convenient. Let f be the strain in the metal in pounds per square inch.

$$a = \pi(r+t)^2 - \pi r^2 = (2rt + t^2)\pi = 2\pi rt,$$

neglecting t^2 (as in steel stacks t is small compared with $2rt$).

$$p = \frac{W}{(2rt - t^2)\pi} \text{ or } \frac{W}{2\pi rt}$$

$$M_o = \frac{P}{2}\frac{(D+d}{2} \times \frac{HH(D+2d)}{3(D+d)} \times 12 = PH^2(D+2D)$$

(in inch-pounds)

$$M_o = \text{(parallel-bodied stacks) } 3\,PH^2D$$

$$M_r = \frac{fI}{r} \qquad I = \frac{ar^2}{2}$$

$$M_r = \frac{far}{2} = f\frac{(2rt+t^2)\pi r}{2} \text{ or } fr^2t\pi \text{ (in inch-pounds)}$$

$$M_o = M_r$$

then

$$PH^2(D+2d) = f\frac{(2rt+t^2)}{2}\pi r = fr^2t\pi$$

$$f = \frac{2PH^2(D+2d}{(2rt+t^2)\pi r} \text{ or } = \frac{PH^2(D-2d)}{\pi r^2 t}$$

Then for stability f is less than p, or $2PH^2(D + 2d)$ is less than W.

For parallel-bodied stacks,

$$f = \frac{6PH^2D}{(2rt-t)\pi r} = \frac{PH^2}{\pi(2rt-t^2)} \text{ or } \frac{PH^2}{2\pi rt}$$

and for stability, $\frac{W}{2\pi rt}$ is greater than $\frac{PH^2}{2\pi' rt}$, or PH^2 is less than W

Now $p - f$ = maximum strain per square inch on the windward or leeward side.

If PH^2 is greater than W, anchor bolts must be used.

Let x = the distance from the center of the stack to a line connecting any two adjacent bolts, F = the maximum strain in any bolt and n = the number of bolts.

Then for wind normal to stack between bolts,

$$F = \frac{3\,PH^2D}{(0.45-0.73n)X} - \frac{W}{(0.45-0.73n)}$$

Value of Constants

n	(0.45 — 0.73n)	n	(0.45 — 0.73n)
6	5	12	9.24
8	6.3	16	12.13
10	7.76	20	15

and for normal to stack at bolts

$$F = \frac{3\,PH^2D}{(0.769n-1.3)X} - \frac{(1.3-0.025n)}{(0.769n-1.3)}W$$

n	(0.769n — 1.3)	(1.3 — 0.025n)	n	(0.769n — 1.3)	(1.3 — 0.025n)
6	3.48	1.16	12	7.92	1.0
8	4.85	1.08	16	11.00	0.9
10	6.43	1.05	20	14.00	0.8

Use the second formula except where $3PH^2D$ is less than BWx where B = for 6 bolts = 1.54
" 8 " = 1.30
" 10 " = 1.22
" 12 " = 1.00

Where the lining is supported by the stack itself, it is necessary to figure the empty unlined stack, as the lining is rarely built until after the steelwork is completed.

*A companion article on "Calculating Capacities of Chimneys" appeared in "Power."

†Formerly mechanical engineer, New York Edison Co.

The anchor bolts may be figured for as low a factor of safety as 3 on the net section at root of thread. It is in all cases advisable to figure P (allowable) as a check for both lined and unlined conditions.

The best construction for steel stacks includes a number of vertical stiffeners riveted to the shell, which support horizontal cast-iron or steel rings on which the linings are built. The vertical stiffeners are usually spaced about 5 ft. apart and the horizontal rings about 20 ft. apart. By this method any section of the lining may be replaced without disturbing the other sections. The thickness of the metal at the top of the stack in such cases is usually $\frac{3}{8}$ in., increasing $\frac{1}{8}$ in. every 50 ft. Stacks in which the linings are not supported may be $\frac{1}{4}$-in. thick at the top, increasing $\frac{1}{16}$-in. every 30 ft.

The maximum value of P is usually assumed at 50 lb. per sq.ft. (corresponding to a velocity of 100 miles an hour), and the foregoing formulas include the reduction to one-half of this value, which is commonly assumed as the force of the wind on a cylindrical surface. For octagonal stacks the overturning moment should be increased one-half, and for square stacks should be doubled.

In brick chimneys practice varies as to the thickness of the walls. The linings are not exposed to wind pressure and consequently can be much thinner than the outside wall, but 100 ft. is about the practical limit of each step. The usual practice is to make the steps about 50 ft. high and 4 in. thick at the top up to 150 ft. high.

For higher chimneys the lining should be 8 in. thick at the top. The outside walls for chimneys up to 150 ft. high may be 8 in. thick at the top, with the steps about 50 ft. high. For higher chimneys the top step should be 12 in. thick, and the upper steps may be as high as 60 ft., with 50 ft. for the lower steps. For stacks built on the Custodis principle the top courses are from 8 to 13 in. thick, depending on the height. The thickness of the molded brick is increased 2 in. every 5 m., or 16½ ft. about.

All brick stacks should have waterproof caps, usually of cast iron, although in many cases they have been made of stone or monolithic concrete. Lightning rods are considered by many engineers a necessity, and doubtless many stacks have been saved by their use. If furnished at all, care should be taken that the conductor and ground connections are good.

Obstructions in the Weak Liquor Line

By D. L. Fagnan*

SYNOPSIS—Troubles caused by rubber from gaskets which plugged the weak-liquor line at the absorber.

Everyone appreciates that the temperature of the cooling water for a refrigeration plant influences its operation and output considerably—especially so in the absorption system. In Texas and other parts of the Southwest the water is frequently extremely hot for months at a time. The plant that I have in mind—a 20-ton absorption system with atmospheric condensers and absorbers—formerly took water from a well, which later developed sand trouble, decreasing its capacity. The cooling tower was much overworked, and the temperature of the water in the supply tank under the tower on this particular day stood at 95 deg. Trouble started when the engineer began to purge the 25-ton brine coolers. This caused the absorber pressure to rise to about 30 lb., and immediately the generator boiled over, there being perhaps a leaky check valve which allowed weak liquor to pass into the coolers. The steam pressure in the generator was 35 lb., but there was not a drop of weak liquor showing in the gage-glass. In about five minutes the absorber pressure rose to 70 lb., and was still going up. The generator pressure rose to 280 lb., and the culmination of events took place so suddenly that the engineer lost his head. Being an erector on the job and having nothing to do with the ice plant, I did not offer assistance, but willingly helped when called upon.

The steam was shut off the generator, and the weak-liquor valve to the absorber was closed, as well as the gas valves from the two vertical brine coolers. Then the relief valves on the generator steam line were opened to the atmosphere, and the speed of the water pump increased. These done, the pressures gradually decreased throughout the system, but there were no indications that the ammonia pump was getting liquor.

When the absorber pressure reached 65 lb., it did not drop further, although plenty of water was going over the absorbers. This pressure should have gone down much more rapidly. That it did not showed that something was wrong somewhere. There seemed to be no weak liquor in the generator, and the pressure in the brine coolers was the same as that in the absorber, which showed that flow of gas between the coolers and the absorbers was not taking place. I shut off two sets of absorbers and allowed one set to remain in service. Into this I turned weak liquor, and the pressure began to drop rapidly. The ammonia pump was started, and in 4 min. the absorber pressure dropped to 13 lb.

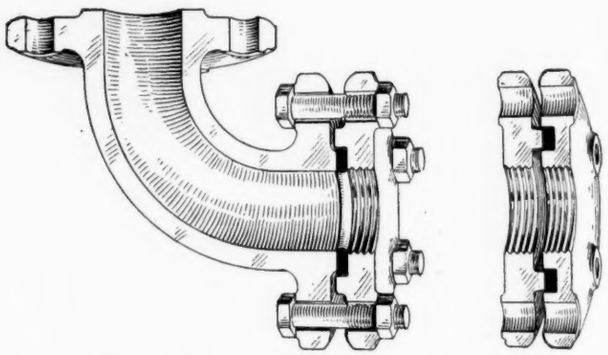
Believing that I had overcome the trouble, I cut in one more coil and found that there was two inches of liquor in the generator gage-glass. I cut in No. 3 set of coils, and almost immediately the pressure rose to 50 lb. and the liquor disappeared in the glass. The pressure, instead of reducing, slowly rose. The faulty coil was cut out, the pressure began to drop, and there was a rush of liquor to the pump, which was kept running until 7 in. of liquor showed in the generator gage-glass. After about a half-hour spent in purging the coils, the liquor level was back at about normal. On removing the aqua ammonia from the faulty absorber coil, all header valves were shut and the pressure was allowed to escape through the purge valve. The ½-in. plug in the line near the injector was removed and the line tried for

*For some years refrigeration and oil-engine troubleman for the De La Vergne Machine Co.

freedom from obstructions by running a wire through the nozzle, but the wire could not be pushed through.

After disconnecting the injector header, a piece of rubber about the size of a large pea was found to be plugged tightly in the nozzle opening, forced there by the generator pressure. The nozzle cleared and everything put in shape, it was not long before the temperature was back to normal, and I was congratulating myself on having so quickly remedied the trouble. The type of joint used let the rubber into the line (see Fig. 1). If a male and female joint (Fig. 2) had been used it would have prevented this trouble.

But just at this time the absorber pressure began to rise again and the liquid level to drop. I ran to the absorber and felt all of the weak-liquor headers to individual absorber coils to locate the defective one, which was found, it being cooler than the others, showing that no weak liquor was flowing into the coolest coil. This was the one that was evidently causing the trouble. I reasoned it out this way: When the set of coils became gas-bound, it automatically made the others gas-bound, the check valves on the coolers closed, and the



TWO TYPES OF AMMONIA FLANGES
Fig. 1—An undesirable design. Fig. 2—The preferred design

weak liquor kept on flowing into the absorber coils, lowering the liquid level in the generator, and there being no overflow to the aqua ammonia receiver, the absorber pressure rose. Being determined to find the root of the trouble, I removed the weak-liquor header and cleared it thoroughly. Many pieces of rubber were found, which had come from the gaskets in the piping system.

Business called me West about sixty miles, and at noon Saturday I received a long-distance telephone call to the effect that the plant was in trouble again. The engineer could not get a flow of gas from the coolers to the absorber, or could not get weak liquor to the absorber. On arriving at the plant I found that screens, Fig. 3, which I had inserted in the header were plugged quite tightly with rubber. The weak-liquor line was cut and a strainer with provision for quickly cleaning inserted.

Considerable experience with obstructions in the weak-liquor pipe on the road has taught me that it is advisable to put self-cleaning strainers on both weak-liquor and aqua lines from the pump to the generator. The strainer in the weak-liquor line will catch any foreign matter that tends to clog the injecter nozzles, and the one in the aqua discharge line from the ammonia pump will catch all small pieces of packing that by accident would pass over to the generator, and by attaching themselves to the outside of the steam coils would coat and gum the coils, preventing a free exchange of heat between coils and ammonia.

Improved Wing Turbine Blower

A turbine blower has recently been placed on the market by the L. J. Wing Manufacturing Co., New York, which, in addition to embodying past improvements in turbine-blower design, includes a radical change in the method of lubricating. Previously the ball bearings were lubricated with grease; now oil is used.

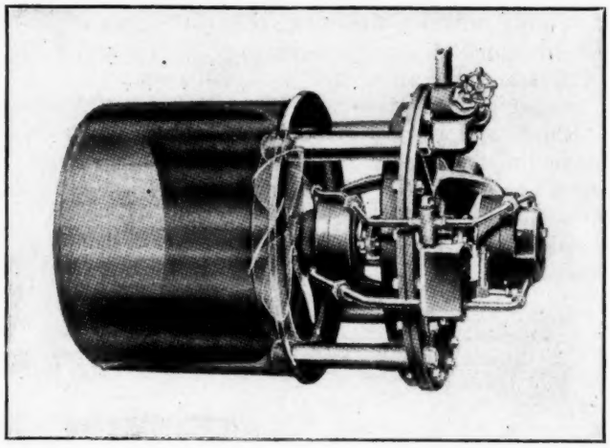


FIG. 1. TURBINE BLOWER, SHOWING OILING SYSTEM

The two ball bearings mounted on either side of the turbine are inclosed in large housings with ample reservoir space to either side of the bearing, so that each bearing rotates through a bath of thin oil, thus insuring positive lubrication.

The oil is supplied from a tank secured to the front turbine face, Fig. 1. The tank *T* is cast with two compartments, *A* and *B*, Fig. 2, one of which is connected to the two bearings. The little oil that gradually works out of the bearings is made up from this compartment, and the latter in turn gets its supply of oil from com-

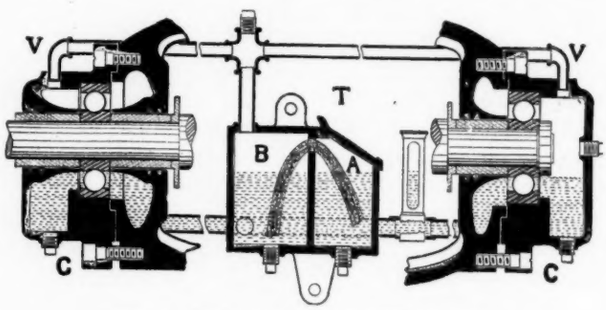


FIG. 2. DETAILS OF OILING SYSTEM

partment *A* into which the makeup oil is fed. Oil is fed from the one compartment to the other by wick feed thus preventing dust and dirt from getting to the bearings. The bearing housings are inclosed, and no dust and dirt can enter them directly. They can be drained through the plug holes *CC*.

The rotation of the machine might ordinarily tend to set up a slight pressure in the bearing housings, and to overcome this the bearings are vented. The vents *VV*

are carried back to the top of the tank, in this way preventing dust getting into the vent pipe.

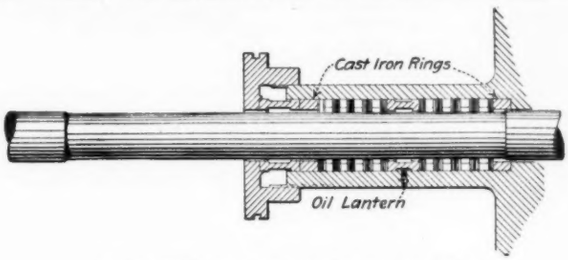
Another feature is the method of mounting the bearings. Instead of the bearing races being held in the main castings in the machine, they are held in the caps, which are secured to the castings. When the cap is taken off by removing four screws, the bearing is exposed and can be easily removed. Should long usage result in wear so that the bearing is not held as snugly as it should be, it is a simple matter to replace the cap with a new one, which will again hold the bearing snug.

The turbine element, while having but a single wheel, is in effect a multiple-stage machine, for by use of the reëntry principle the steam is redirected after leaving the buckets and strikes the same rotor several times in succession, thus extracting the velocity of the steam and adding to the economy of the turbine.

Shoulders on Compressor Piston Rods

By Carl Jefferson

In the operation of ammonia compressors, especially those with a deep stuffing-box, one finds that after one or two seasons' run the packing has worn a shoulder on the rod—usually two shoulders, one at the lower and another



CAST-IRON RINGS IN STUFFING-BOX

at the upper end of the rod, the distance between being the rod travel through the packing in the stuffing-box. These shoulders will punch the top and lower rings of packing and destroy them in a short time, and practically prohibit using a metallic or semimetallic packing without having the rods turned true.

To get another season's run out of the machine without turning off, the rods have cast-iron rings made for the top and bottom of box, the outside diameter of the ring fitting neatly in the bore of the stuffing-box, and the inside diameter of gland $\frac{1}{32}$ in. larger than the large diameter of the rod. The rings prevent the shoulders on the rod coming in contact with the packing.

Phase Failure and Phase Reversal Relay

The Cutler-Hammer Manufacturing Co., of Milwaukee, Wis., has recently developed a phase-failure and phase-reversal protective device that provides protection against failure of any of the phases, phase reversal and excess drop in the line voltage.

The device is shown in Fig. 1 and consists essentially of a small two- or three-phase motor arranged so that when properly energized the rotor revolves through a small angle against the tension of a spiral spring, and in doing so closes the relay contacts *C* and *C* shown at

FIG. 1. PROTECTIVE RELAY FOR ALTERNATING-CURRENT MOTORS

the top of the figure. The relay switch *S* is shown in Fig. 2 and is designed to make and break single pole the control circuit of the motor controller, which connects to contacts *C*.

The device remains energized throughout the operation of the apparatus with which it is used. If the supply voltage falls below 70 per cent. of normal the torque of the relay motor will not be sufficient to hold the relay closed. The relay is then opened by the spring and held open until the voltage returns to at least 85 per cent. of normal.

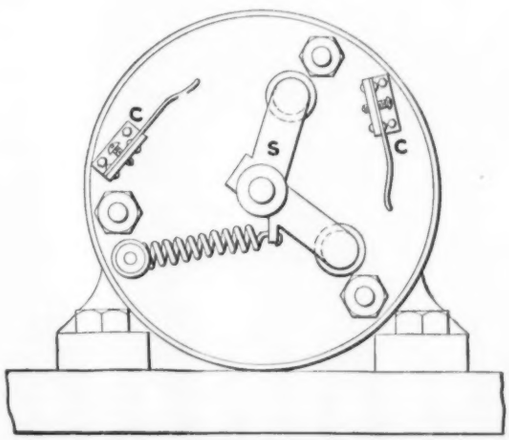


FIG. 2. SHOWS RELAY SWITCH

In case of phase failure caused by the opening of one of the supply lines, if the motor is under any appreciable load the voltage across the relay terminal will drop to a point where the relay will open the circuit and keep it open until the fault is repaired. When one phase of the circuit is reversed, the turning influence on the relay rotor is opposite to that of normal, and whether the reversal of the phase occurs with the device energized or otherwise, the protection is positive, for in the first case the rotor will immediately reverse and open the auxiliary switch, while if it is connected to a line the phases of which are reversed from that which it is intended for normal operation, the rotor will tend to carry in a direction opposite to that necessary to close the auxiliary switch.

In many cases the application of this device is essential to protect human life and prevent mechanical injury to the apparatus. The accidental reversal of some classes of machinery is often accompanied with considerable damage to the equipment. In the case of elevators, aside from the mechanical injury that may be done to the car running into the overhead work, there is always the liability of injury to passengers or operator. The ordinary safety devices provided on elevator equipments do not protect against the accidental reversal of a phase unless overtravel limit switches are provided.

In the case of phase-failure protection, the device has advantage over the use of potential relays, for the reason that it is adjusted to release upon a given reduction in the line voltage, while the solenoid or magnet-operated relay is usually not sufficiently sensitive to be adjusted to open upon a given reduction in voltage. Upon the opening of one leg of the line of a polyphase system, it is not a case of zero potential in that particular phase, but on the contrary merely a reduction in the line voltage which takes place, due to the transformer action of the motor connected to the open phase.

The Kingsford Boiler

The illustrations show the boiler manufactured by the Kingsford Foundry and Machine Works, Oswego, New York, which is of the compound Lancashire type. The hottest gases pass through the large flues, through the boiler, passing again to the front of the shell through the small or "smoke," tubes, to the breeching. The idea is to provide the principal heating surface near the surface of the water, so that the steam formed may get to the steam space by the shortest route and in the quickest time. Notice that the setting is free from the sides of the shell. Solid stays and stay-tubes are used between the heads.

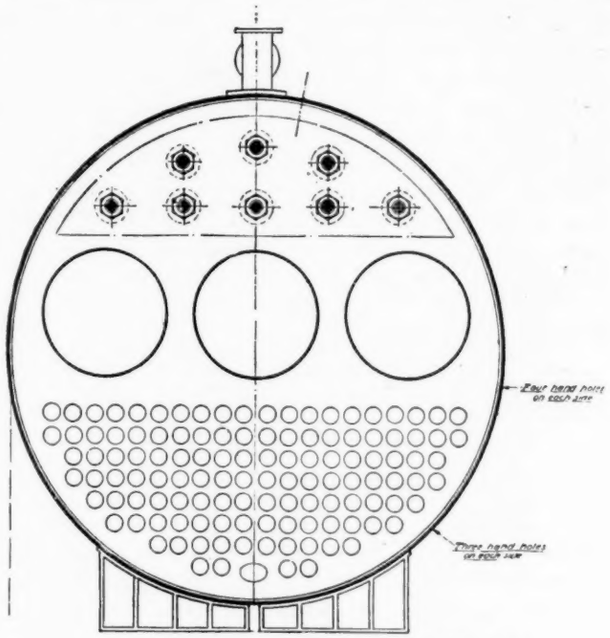


FIG. 2. END VIEW, KINGSFORD BOILER

Cast-Iron Pipe is cast in various lengths and shapes, with ends to suit the kind of joint construction to be used. For underground water lines the so-called bell-and-spigot type of joint is in general use. Cast-iron pipe with flanged ends, to be joined together with bolts, is not in as general use as formerly, and for steam lines it has properly given way almost entirely to wrought iron and steel, but for boiler-feed lines, where destructive action is observed in wrought iron or steel pipe, cast iron may be successfully used.

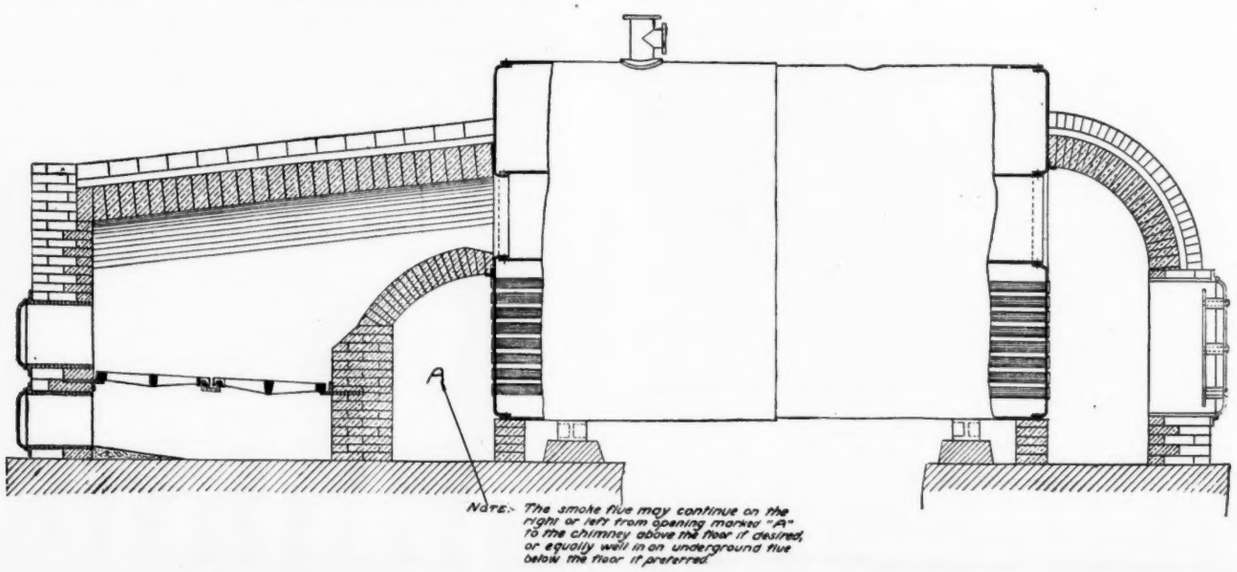

A
Note:- The smoke flue may continue on the right or left from opening marked "A" to the chimney above the floor if desired, or equally well in an underground flue below the floor if preferred.

FIG. 1. SECTIONAL VIEW OF SETTING OF COMPOUND LANCASHIRE BOILER

Editorials

"Standards for Electric Service"

Elsewhere in this issue is published an abstract from Circular No. 56, "Standards for Electric Service," of the Bureau of Standards, in which the bureau attempts to present a survey of the general field of state and municipal regulations in so far as standards of electric service are concerned and presents suggested rules and regulations that may be adopted as proposed or that may form the basis for rules and ordinances to be adopted by states and cities.

One of the important subjects of standardization and commission regulation today is electric service. It is not enough that electric service be adequate; it must also be safe. The bureau is to be highly commended for its efforts toward forming codes for electric service; what it has accomplished so far is a worthy task. Even if these codes never became national in their application, there is every reason to believe that they will be of inestimable value to states and municipalities in forming rules and regulations governing public utilities.

The bureau has been seriously criticized for some of its efforts, especially the "National Electric Safety Code." One of the many objections put forward was that standardization in a rapidly developing art would tend to discourage initiative. There may be some ground for this statement, but this does not seem probable in the light of what has been accomplished under our various standardization rules. The advancement that has been made would indicate that standardization stands for progress and not stagnation. That all of our standardization codes have been beneficial is something that cannot be disproved. One of the oldest national codes regulating electric service is the "National Electric Code for Electric Wiring." Has this been a hindrance to the development of the electric industry? The indications are the other way. When this code was created, the electric industry was in embryo and devices that are in use today were not even dreamed of in 1897, let alone their use recommended. Did the manufacturer say, "My materials meet the National Electric Code" and quit at that?

The facts of the matter are that the progressive manufacturers have gone ahead and, instead of merely meeting the requirements of the rules, have made their materials of a quality superior to that required by the code. Consequently, at each revision it has been a case of bringing the code up to the standards set by the manufacturers.

Another notable example of the foregoing statement is found in the application of the A. I. E. E. "Standardization Rules." This body has no mandatory power whatever to enforce its code, but each time that these rules have been revised the new edition has been made more exacting than the previous one, to meet the progress that has been made in the meantime. One of the ambitions of the electrical manufacturers is to meet the requirements of this code, and when they do, they very proudly, and rightly so, advertise the fact that their apparatus meet the standards prescribed by the A. I. E. E.

Now that electrical machines and fittings of every kind are being made to meet certain standards, it would seem fitting that service supplied from these equipments should also conform to standards, both as to adequacy and safety. If such a code was adopted, it seems reasonable from past indications, that the central stations would be endeavoring to do just the same thing that the manufacturers are doing; namely, not alone meeting the standard codes, but surpassing them. Many of the central stations today, although they may be opposed to the adoption of certain codes for standard service are nevertheless looking for means to improve, or at least to insure a more reliable and adequate service.

The Cleveland Municipal Plant

If it can be successfully demonstrated that a central station can furnish electricity at a maximum rate of three cents per kilowatt-hour and meet all the expenses that can be legitimately charged against it, the fact is apt to have a telling effect upon rate schedules and upon power-plant interests as they are affected by returns to central stations, or the displacement of the isolated plant by boughten current. It is natural that every means should be resorted to to discredit the performance of the Cleveland municipal station which is claimed to be doing this, and a recent outburst in the columns of *Public Service* makes it a complete failure and predicts its speedy abandonment.

The first year or two of its existence is naturally the most trying for any such enterprise, as it is not yet, for lack of connected load, earning its full income, although it is burdened with its full overhead charges. The real facts in the Cleveland case, so far as *Power* has been able to ascertain them, are that the revenues of the plant exceeded its operating cost for the year 1915 by $217,721.41.

The number of subscribers on Jan. 1, 1915, was 9,076; on the same date of the present year, 15,508; and up to June 1 of the present year there had been added 1,273 more. The total number of customers of the plant, May 1, was 16,187. Starting the year with 1.7 times as many customers, with this rate of increase the station will have a greatly enlarged revenue upon the same investment for the coming year.

One of the principal methods of attack, therefore, is to prevent or deny this increase, and in a recent issue of *Public Service*, Lighting Commissioner Davis is made to say: "We have no money to make extensions, and have to cut down our force forty per cent. No new customers are to be taken on for the present."

The reduction of force was due to the laying off of men who had been installing a new decorative street-lighting system. The money available for this purpose is exhausted, but the principal part of the system is complete and it is in operation in the chief thoroughfares of the city. The cost of the extensions has been paid and is still being paid out of the profit. There has

been criticism because the plant was not charged with depreciation in addition to sinking fund. When depreciation is paid, it must be credited to the capital account. It is virtually the withdrawal or retirement of so much of the investment. The interest charges then become proportionately less. If the money set aside for depreciation is again invested in the business, it is recharged to the capitalization account. Depreciation has been paid, improvements effected; but the original capital is all in, and full interest must be paid upon it.

It is in this way that the Cleveland plant meets its depreciation charges and finds at the same time the money for extensions.

For the first three months of the present year the net profits were $116,125.54, out of which $29,240.88 were expended for new construction, additions and extensions, and connecting up new customers. If the other quarters are equally good—and the conditions are improving and the load growing all the time—this would give an annual surplus of $347,539 to take care of overhead charges, which (outside of the depreciation already taken care of, as explained above) amount to $254,850. This would seem to leave a comfortable margin.

Attempts to discredit the plant as a plant will be frustrated by a visit to the station, or even by the reading of the published descriptions of it. The equipment is practically new, in good condition and excellently selected for its purpose. A recent visit by a *Power* editor showed intelligent, interested management and no reason why the station should not produce the results that are claimed for it.

Constant reiteration of false and distorted statements may induce a popular impression that the Cleveland municipal station is a failure, but what the engineering world, particularly the power-plant engineer and, incidentally, a large current-consuming public want to know is whether the station is self-supporting at three cents per kilowatt-hour; and if it has demonstrated this fact, no amount of abuse and misrepresentation, nor Public Service accounting legerdemain, can neutralize the ultimate result, even if they succeed in putting the station out of business.

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Forced Hot-Water Heating

On other pages of this issue is the description of a hot-water heating plant of exceptional interest. It was designed and installed by an employee of the Crane Company and, to his credit, has been giving excellent satisfaction. To begin with, conditions were ideal for forced hot-water heating. The buildings are mostly two-story structures spreading over large areas, and all are connected by a system of tunnels. Months of investigation were spent in seeking the relative merits of steam and hot-water heating and in observing systems already installed. A summary of all data collected pointed toward hot-water heating as the best system to install in this particular case. It would be the easiest to operate and maintain. Regulation from the power plant would be simple, and the returns would not get outside of the building. The possibility of varying the temperature of the heating medium to conform to outdoor temperatures was an important advantage and one that would save a great many heat units in moderate weather over a steam system with or without fractional regulation.

An innovation that has proved its worth was the division of the system into seven circuits. This arrangement made it possible to install piping of moderate size and avoided complications that would have developed had all the buildings of varying height been attached to the one system. Better distribution was obtained, and regulation from the power plant of independent buildings or groups of buildings was possible. For example, the administration building needs heat when the shops can do without it, and in colder weather it can be maintained at a higher temperature.

As will be apparent from the description, the regulation is unusually complete and efficient, and with recording meters to show continuously the temperatures of the outgoing and return water it is easy to follow a predetermined schedule conforming with outdoor temperatures. Rather than vary the speed of the pumps and in turn the velocity of the water, as is frequently done to meet changing conditions, regulation is effected by automatically controlling the supply of steam to the heaters, a feature tending to increase the economy and minimize attendance.

The generous use of lock and shield valves in this plant may be criticized. It is certain that they introduce resistance into the circuits and cause additional work for the pumps, but when once set, they insure the proper supply of water to each connection and equalize irregularities in sizing the piping such as might easily occur in laying out a large system.

However, the proof of the pudding is in the eating, and on this basis a year's service speaks well for the installation. Little attendance has been required, troubles and repairs have been negligible, the service has been excellent, and although accurate figures are not available, it is safe to assume that the economy was on the same high plane. After the installation of certain meters, operating cost figures will be available, and these will be received with a great deal of interest.

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It has been reported that the city council of Minneapolis has declined permission to an isolated electric power plant to construct conduits for the purpose of running wires to serve another building. The council took the ground that the permit would be against public policy, because the granting of such permits would be inconsistent with the maintenance of lower rates in the business section by the central-station company serving the city. Such public policy has the earmarks of central-station backing. Throttling legitimate competition does not usually react to the benefit of the public. It gives free rein to the monopoly to charge all the traffic will bear—a policy not new to the central station.

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We do not know just how many colleges and universities maintain extension courses of various kinds useful to engineers, but we have often wondered how many young men in power plants who would be greatly benefited by such courses study them.

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The railroad-strike agitation caused one to speculate on whether stationary engineers would act as arrogantly as locomotive engineers if they had been similarly pampered by a sentimental public.

⁂

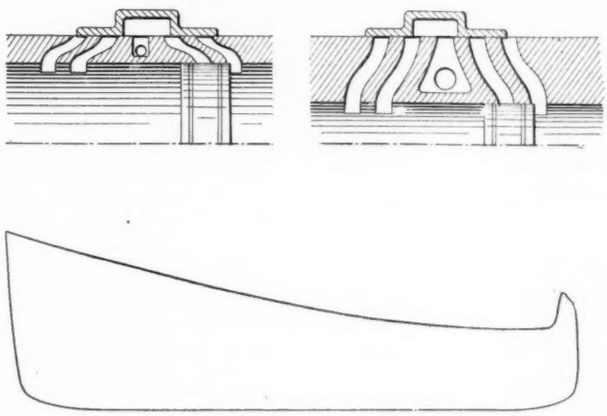
Piston Turned Top Side Down—Headline. We have known of Corliss valves being put in that way.

Correspondence

Misadjusted Steam Valves

A compound duplex pump would jump the last two inches of the stroke and at times would strike the heads regardless of how the cushion valves were set.

When the pump was overhauled, it was found that the low-pressure valve had ½ in. more slack motion than the high-pressure. Since one stem worked both valves, which



RELATIVE POSITION OF VALVES, DIAGRAM PRODUCED

had no lap (a condition common to duplex pumps), this allowed one end of the high-pressure cylinder to start exhausting before the steam valve for that end of the low-pressure cylinder closed, as in the position of the valves shown in the illustration, which resulted in a high terminal pressure in the low-pressure cylinder. This explained the jump at the end of the stroke. The valves were set so that they operated together and both had the same motion, and now the pump is under the control of the cushion valves and runs quietly with less steam than before. HARRY D. EVERETT.

Washington, D. C.

Synchronizing Alternators

On page 105 of the July 18 issue of *Power*, Thomas M. Gray described a method of synchronizing alternating-current generators. On page 288 of the Aug. 22 issue, Harry E. Erskine makes some comment on this scheme. I have seen the plan described by Mr. Gray in use for six years, without any mishap whatever. It may seem a bit hazardous at first, but a little practice is all that is required.

The plant that I refer to has six 180-kv.-a., 2,300-volt generators direct-driven by gas engines through flexible couplings. The throttle is the gas valve, the governing being done by the quantity method. The engines are brought up to the regular speed, then the gas valve is moved over to a certain graduation, predetermined by trial, as in Mr. Gray's case. When the synchronizing plugs are inserted in their respective places, it requires very little manipulation of the gas valve to bring the machines into step.

My experience has been with generators connected by flexible couplings to their prime movers. If the two generators are switched in without being in step—I mean when the needle of the synchronoscope is still in motion—the couplings break and save the machines. I have seen a few smash-ups by careless synchronizing. In each case it was either the connecting-rod or the crankshaft that broke, usually the connecting-rod bolts. G. STROM.

Brooklyn, N. Y.

Location of Lubricator

In regard to Mr. Ralston's lubricator trouble as described in the issue of June 27, page 922, I am convinced that the proper location for a lubricator is upon the cylinder or steam chest of the engine, for when so placed, the temperature of the oil remains practically constant; otherwise its temperature changes and the ball valves in the pump cannot seat quickly.

When the oil becomes thick and the ball has a tendency to float, part of the oil is forced back into the reservoir before the valve closes. The same problem is encountered where any heavy liquids have to be pumped. The liquid having been allowed to stand inert becomes cold and thickens, chokes and clogs up, contracting the area of the passage, clings to all parts and makes it difficult for the pump to work properly. THOMAS M. GRAY.

Middletown, N. Y.

Gratuitous Reactance

In the article by E. C. Parham in the Aug. 15 issue there is related an experience similar to one I had some time ago while connected with a large clay-mining company operating a number of mines. A new dredge that failed to give satisfaction was equipped with one 200-hp. 440-volt motor, driving a three-drum hoist for dipping kaolin, one 100-hp. motor used to drive a centrifugal pump and one 40-hp. motor driving a small turbine pump—all motors drawing current from three transformers located on the bank of the pit, the feeders being supported on pontoons.

The installation was made by the local electrician employed by the company. When everything was in readiness for the dredge to be put in operation, the different starters were placed in the running position, but the motors failed to come up to speed and the boat resembled a monster buzzer, every loose part on it vibrating whenever the current was turned on.

I was called in to rectify the trouble, if possible, as the dredge was needed at once. I was met at the station by the electrician, who advanced all kinds of wild theories as to the probable cause of the failure of the motors to operate and the boat to show vibratory symptoms from static to wrong name-plates.

The thing that attracted my attention first was three large wooden reels of wire side by side on the rear deck of the dredge, and on inquiry was told that the idea

originated in the electrician's mind, he thinking to save labor and time when moving the dredge by having the feeders run to the reels and merely unwinding the wire as needed to allow the dredge to move farther out into the pit, thus eliminating the necessity of splicing.

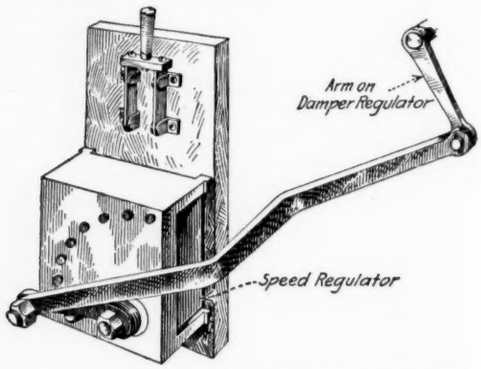
The reels were mounted on stands, a circular contact being fastened to one side of each reel, with a brush arranged to collect the current. The idea was ingenious, to be sure, and would have given satisfaction but for the reactance of the coils. The coils, starting to vibrate, transmitted the motion to the boat, besides lowering the voltage at the motors.

The connections were checked as a precautionary measure and found to be correct. The reels were removed and the feeders run straight to their respective motors, which then operated normally and the dredge ceased vibrating. The time required for the examination and checking was two hours. Voltage readings were not taken, but I think from the indications of the motors it must have been less than half normal.

Lakeland, Fla. GROVER C. LONG.

Motor-Operated Stoker

Stoker engines are usually not well attended to and are so located that the dust and oil mingle in a sticky mass which makes the engine hard to clean. Our chief has substituted a motor drive located outside of the boiler-room



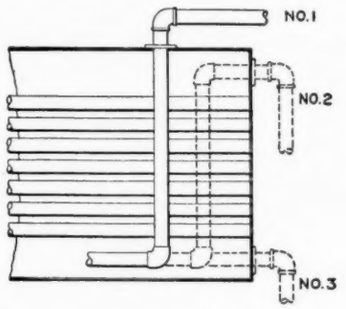
DAMPER REGULATOR OPERATED SPEED CONTROL

wall and driving a shaft in turn belted to the chain-grate countershaft. The speed regulator is connected to an arm of the damper regulator by a rod, as shown in the illustration. This operates the grates more satisfactorily than the steam engine and requires but little attention.

Chicago, Ill. F. F. SENGSTOCK.

What Blistered the Boilers?

I think George F. Wright's trouble with the boiler sheets blistering, as described in the issue of Aug. 1, page 173, was the result of poor circulation, and this in turn is produced partly by the feed pipe being connected to the blowoff at the rear, causing the sediment in the boiler to be driven to the front, and partly by the construction of the front arch, allowing cold air to impinge on the spot blistered each time the door is opened for firing. Cold air striking the plate will stop the circulation, and the sediment will at that time settle on the cold spot and concentrate the heat there when the doors are closed. The firemen may be in the habit of carrying a thick fire under the spot blistered, thereby increasing the heat on that part of the plate, and the feed water entering at the rear causes the sediment to settle on the same spot. I think that introducing the feed water at the front, either through the front head below the tubes or above the tubes and extending the feed pipe inside the boiler to a point below the tubes and discharging toward the rear end of the boiler, then blowing down the boilers regularly, will correct the trouble. The illustration shows three ways of introducing feed water in a return-tubular boiler, either of which will aid circulation and prevent deposits



THREE SATISFACTORY WAYS OF FEEDING BOILERS

at the front of the boiler. No. 3 is usually the easiest connection to make, but No. 1 is perhaps the most satisfactory. It can be carried either down between the tubes at the center or around the side of boiler between shell and tubes. A. A. BLANCHARD.

Ringwood Manor, N. J.

My opinion is that the trouble is caused by feeding the boilers through the blowoff, as that sends all scale and other foreign matter toward the front end of the boiler, interferes with the circulation and deposits the scale over the hottest fire.

I feel sure that if Mr. Wright will change the feed pipes to the front head, he will have no more trouble from blistering or bagging. Drill and tap out a hole in the front head about 2 in. above the top row of tubes and screw in a nipple with long threads. Get inside, screw on a coupling and a piece of pipe about two-thirds the length of the boiler, put on a tee and extend pipes out to each side of boiler, then down between the outside row of tubes and the boiler shell to about the second row of tubes. Blowing off about four times in 24 hours gets rid of a lot of sediment. LEO M. WILKINSON.

Nacogdoches, Tex.

The question by Mr. Wright is plainly answered in the statement, "We feed through the blowoff at extreme rear end of the boiler." The comparatively cold water entering at the rear follows along the bottom of the boiler, taking the loose foreign matter along with it, and then rises, leaving on the sheet the sediment that is too heavy to rise with it; the extreme heat at this point does the rest. There are special rules for feeding this type of boiler and they are based on good grounds, but I think the worst possible feed is through the blowoff. It has only one good point, that of protecting the blowoff pipe where it passes through the combustion chamber, but this is not enough to commend the practice, since there are several other ways of securing this protection.

It is a good plan in any type of boiler to extend the feed pipe inside the boiler so that the feed water will be at nearly the temperature of the water in the boiler before it is liberated. The point of liberation and velocity of feed will tend to increase or diminish the circulation of boiler water. Therefore the direction of flow and the point of discharge should be chosen to help along the natural boiler circulation. This is a subject that needs some study. It has been my experience that some return-tube boilers circulate water in different directions than others; also that the settings, point of feed discharge and amount of draft have considerable to do with it. Moreover, the method of handling the fires sometimes makes a difference. There is no rule to fit all cases. However, it is plain that the present feed is a failure; therefore try another and be assured that it cannot be worse. L. JOHNSON.

Exeter, N. H.

[The following appeared in *Power* not long ago on the same subject: About the only excuse for feeding a boiler through the blowoff is that it helps keep the pipe clear. A circulating pipe connected outside of the setting will do as well and allow the boiler to be fed in a safe manner through an internal feed pipe.—Editor.]

Sulphur Content in Steel

Most manufacturers realize that abnormal results may be obtained and are generally attained when methods and processes of manufacture are the subject of research. May not Dr. Unger's contradictory results, page 144, July 25 issue, as to the influence of sulphur in steel be due to an enthusiastic interest of the working force which manipulated the test pieces of steel through their several processes of manufacture? This interest may have been unconsciously inspired by the research department.

In the manufacture of gray-iron castings the metal is not worked while hot, hence sulphur shows its true influence on the quality—increasing brittleness, shrinkage strains, red shortness and blowholes which frequently contain sulphur gas. The clever foundryman knows that he can make sound and strong close-grained castings with a high sulphur content, provided all the precautions known to the trade are observed. But here's the rub—the human element enters, one safety precaution is omitted and the undesirable influence of sulphur is sure to appear in the finished castings. Therefore the foundryman naturally reduces the sulphur content to a minimum and thereby lessens his casting loss, although results similar to those obtained with steel may be secured in cast irons; and most foundrymen are aware that an increase of sulphur will raise the breaking strain on test specimens that are thoroughly sound, homogeneous and free from shrinkage strains.

Table 3 on page 145 (July 25) shows that the sample having a sulphur content of 0.09 has the greatest strength. It is interesting to observe that cast iron having a sulphur content of 0.09 to 0.12 frequently has greater strength than lower-sulphur irons. Nevertheless the latter are preferable because of their more uniform quality.

The point I wish to emphasize by the foregoing is that undoubtedly the manipulation of the test specimens during the process of manufacture was superior to common usage, so that those of high sulphur showed equal or superior physical qualities to those of low sulphur.

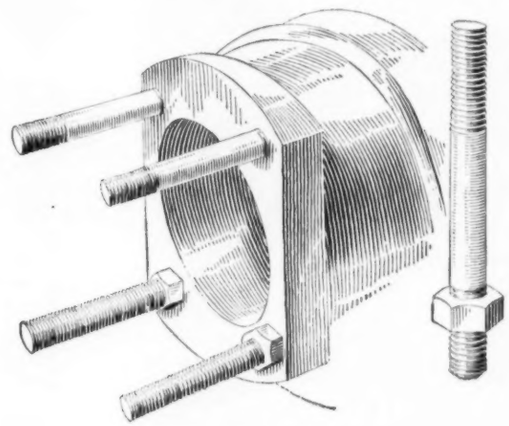
Before convincing men who use and work steel that high sulphur content is not detrimental, it will be necessary for them to learn to work high-sulphur steel so as to get as uniformly good results as with low-sulphur steel.

A striking physical evidence of the brittleness of high-sulphur steel is that the chips will crumble and fall away from the die chasers, while low-sulphur steel is threaded with more difficulty, because the chips curl and clog before the die, causing the metal to be torn.

Holyoke, Mass. ROBERT E. NEWCOMB.

Locknut on Gland Stud

We have a boiler-feed pump with 5⅞-in. plungers that has caused a lot of bother by the gland studs breaking off where they screw into the pump body. I have found a way to overcome this trouble by threading the whole length of the stud and screwing a locknut up against the pump to act as a support and to keep the stud solidly in place. It is a great improvement over the original design. For long studs or ones that cannot be threaded their entire length, the thread may be cut enough longer than the threaded hole to receive the nut also, in which case the nut is backed on first, then the stud is screwed into the casting snugly and the nut is tightened up against the casting last. The illustration will make the matter clear.



APPLICATION OF LOCKNUT

Trenton, N. J. STANLEY SMITH.

Rigid Cylinder Supports

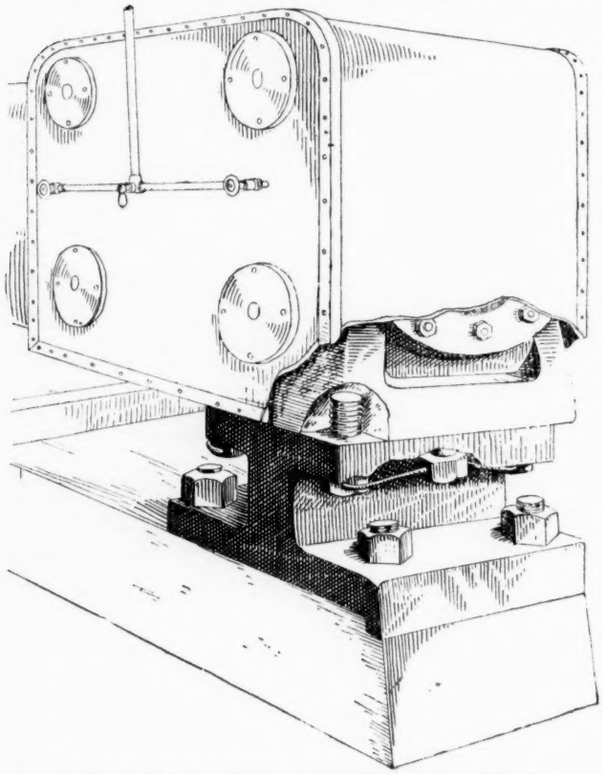
Some time ago there appeared several articles concerning the breaking of the studs holding cylinders to their pedestals, and the means to overcome the difficulty. One man told of cutting a keyway crosswise of the cylinder and lengthwise of the pedestal and inserting a key.

In the plant where I am employed are two cross-compound engines that had run for about six years when the studs holding the cylinder to the frame began breaking, the trouble making itself manifest by partly blowing the gaskets. On renewing one of these gaskets and a new set of studs it was found, when bolting the cylinder to the frame, that the head end of the cylinder did not rest on the pedestal by about $\frac{3}{16}$ in.

The studs holding the cylinder to the pedestal were frequently breaking or becoming loose and dropping out.

A view of the pedestal and studs is given in the illustration. The nuts on the pedestal foundation bolts would also work loose.

The spring in the cylinder and the long frame of the engine caused an appreciable movement endwise of the cylinder. This, when the studs and pedestal foundation



STUD BOLTS WIRED TO PREVENT TURNING

nuts were tight, caused either the studs to break or work loose, or the pedestal nuts to loosen. Sometimes the foundation nuts holding the pedestal would loosen sufficiently to cause the pedestal to move with the cylinder.

The rubbing action of the pedestal on the concrete foundation wore the latter away and let the pedestal down. Every time these nuts were tightened, considerable strain was put on the studs holding the cylinder to the frame, finally causing a few of them to break.

My belief is that it is foolish to attempt to hold a cylinder rigid with the pedestal, for it is well-nigh impossible to prevent springing in the engine frame and cylinder. It surely would be impossible unless the restraining force could be applied at the center line of the cylinder; besides it is not necessary.

If the cylinder has a support that will take its weight and keep it level with the frame, the end motion is not detrimental and, therefore, the cylinder should not be fastened rigidly to the pedestal. Many small engines are built with an overhanging cylinder, and I can see no reason to attempt to hold a large cylinder rigid, especially with the pedestal so far from the center line of the cylinder. It would be a better idea if the builders would place a roller or some kind of joint between the pedestal and the cylinder, to allow the latter to move rather than try to constrain it.

In our case we raised the pedestal to the proper height and bolted it down solid. Instead of bolting the cylinder tight to the pedestal we put the cap bolts in just far enough for the heads to touch. Holes were drilled through the heads, and a wire was run through them to prevent them from backing out.

The cylinder is now free to move on the pedestal while the latter remains rigid. It would probably make little difference if the cylinder was not bolted to the pedestal at all; in fact in one plant where I was formerly employed, one engine had the rear pedestal broken all the way across and ran that way for years, giving no trouble.

It would be interesting to hear the views of other engineers on this subject.

JOSEPH STEWART.

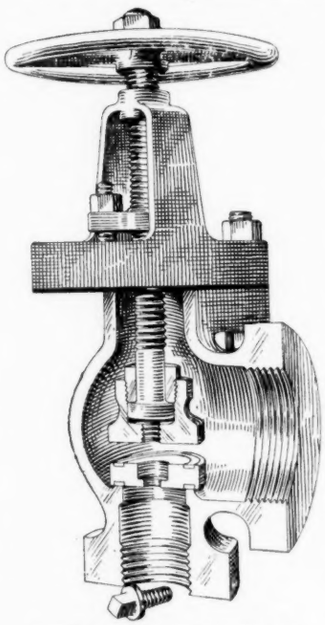
Hamilton, Ohio.

Defective Blowoff Valve

An accident, in which three men were scalded with hot water while working on an economizer blowoff valve, occurred recently in a large power plant in the Middle West.

The blowoff valve had been troublesome and would not always seat properly, so the economizer was cut out of service, blown down and allowed to cool overnight with the blowoff valve stem all the way up.

In the morning there was no discharge from the pipe, and the blowoff sewer was perfectly dry. Therefore, there was apparently no pressure on the apparatus. The body bolts had been removed from the valve and the bonnet had been pried an inch or two from the body with pinch bars, when suddenly it was blown off by pressure from within, scalding the men with hot water and mud. When the valve was examined, it was found that the opening in the seat was only 1¼ in. in diameter instead of 3 in. It was also learned that the valve had been in this condition for about two years and that the foreman of the boiler house supposed it had been made that way. As a matter of fact, the renewable and reversible disk had worked loose from the holder and become jammed into the seat proper, and the stud had stripped its threads and dropped out, so the valve had only the small opening through the disk center. When the lug on the bottom of the disk holder entered the hole in the disk, the valve would close properly; but a slight accumulation of scale would cause the lug to bind or catch the edge of the opening and allow an excessive leakage to take place.



DISK LOOSE FROM STEM

This restricted opening had evidently become blocked with scale and mud, when blown down last, in such a manner as completely to seal the opening; and the feed or inlet valve had allowed water to leak into the economizer, although this valve was new and the foreman had closed it carefully. The stopping up of the blowoff valve, therefore, allowed a pressure to accumulate within the economizer, and the mud and water found an outlet when the bonnet was loosened.

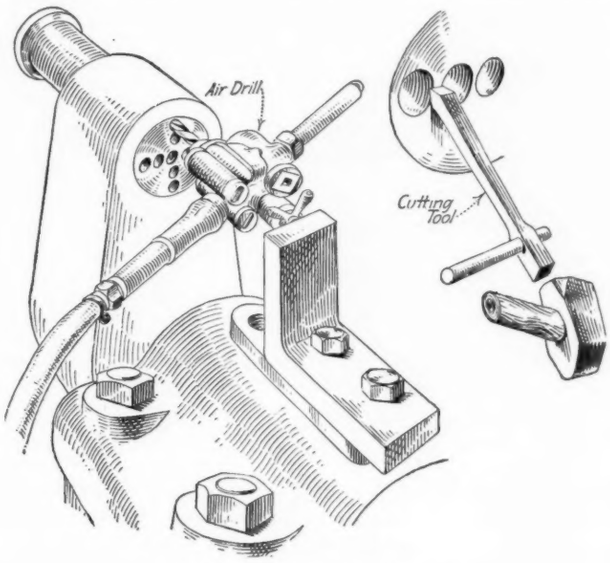
Accidents of this kind could be avoided by taking more time and precautions to see that there is no pressure on the apparatus before making repairs. Opening an air vent, or loosening a few caps on the lower header, would have saved the men their painful injuries.

Appleton, Wis. A. W. CONKLIN.

Removing a Loose Crankpin

A crankpin on a large engine was reported as being so loose that oil showed working out from the fit. It was thought best to drill the pin. The engine was pried over to the top quarter and the headed-over part of the pin was then chipped off.

A strong angle iron was made and bolted to the main bearing cap after the oil cups had been removed, and an



DRILLING THE CRANKPIN

air drill was braced against this frame, as shown in the illustration. The pin was then laid off and drilled with 1-in. holes, starting in the center and drilling in four directions. The metal that was left between the holes was cut out with a tool made for the purpose. When the press was used, the metal on the outside of the pin was forced toward the center and the pin came out easily.

The cutting tool was made so that a handle could be used, one man holding the tool while another hit it with a sledge hammer. W. E. TAYLOR.

Methuen, Mass.

Low-Pressure Turbine at Dayton

On page 130 of the July 25 issue, there is an article regarding a 7,500-kw. bleeder-type turbine installed at Dayton, Ohio. A statement is made as follows: "Twenty men each working fifty hours per week for a period of seven months were employed in erecting this turbine."

The turbine was erected by the construction force of the Cincinnati office of this company, unloading of the turbine shipment having started on Nov. 13, 1915, and the machine having been started on Dec. 17. At no time were more than six men engaged and no overtime or Sunday work was performed.

The tests referred to were started on Mar. 1 and completed on Mar. 10.

I will be very glad if you will publish this correction.

W. S. CULVER,
District Engineer, General Electric Co.

Cincinnati, Ohio.

He Was "Just Fooling"

Soon after a young fellow who knew nothing about electricity started to work in a power plant, a so-called practical joker set him to work repairing some lamp sockets with the current on, telling him to hammer the insulation and scrape it off with a knife.

The "cub" got a flash that blinded him for a short time and burned his hands badly. The short-circuit opened the circuit-breaker on the street-car line, and it was not detected for half an hour or more, after repeated calls from the office, and the irony of the thing was that the "cub" was the one who finally saw it.

The so-called "practical joker" should be kept severely away from the power plant. R. G. CURREN, JR.

Kittanning, Penn.

Engine-Room Lubrication

The article by Mr. Townsend, page 905 of the June 27 issue, is interesting and should do much to convince engineers of the savings that can be effected by the proper lubrication of power-plant machinery.

The latter part of the article points out the necessity of providing a liberal amount of filtering surface. However, I have found that there is considerable misunderstanding in regard to the amount of filtering surface that a modern power-plant oil filter should have, or rather, too much importance is frequently given to the quantity of surface included in the filter while the effectiveness of this surface is disregarded. One frequently sees specifications calling for a certain quantity of filtering surface, but no mention of the arrangements of the surface or its efficiency is made. This is like buying an engine by the pound and making no mention of the steam economy.

Quantity of surface alone is by no means a gage of the efficiency of an oil filter. One might take a circus tent with thousands of square feet of surface and wad it up and get it in a comparatively small filter, but the efficiency of the surface would be very low. On the other hand, one might stretch out this same quantity of cloth in a single horizontal layer so that it is free from folds and every square inch is effective in filtering oil, and if the oil passed downward through the cloth, a layer of sediment would soon form a cake over the surface, greatly decreasing its efficiency.

A modern oil filter is designed to be somewhere in between these two extremes, but the main thing to take into consideration is not quantity of the surface, but its physical arrangement. It is evident that for the filtering surface to be effective, it should be arranged so that every square inch is active in passing oil, and that the cloth be arranged so that it is free from folds, which impede the flow. The efficiency of filtering surface is increased if it is arranged vertically, and practically all modern commercial oil filters have vertical filtering surfaces.

I have seen a number of home-made filters in which the cloth has been arranged horizontally, and the sedi-

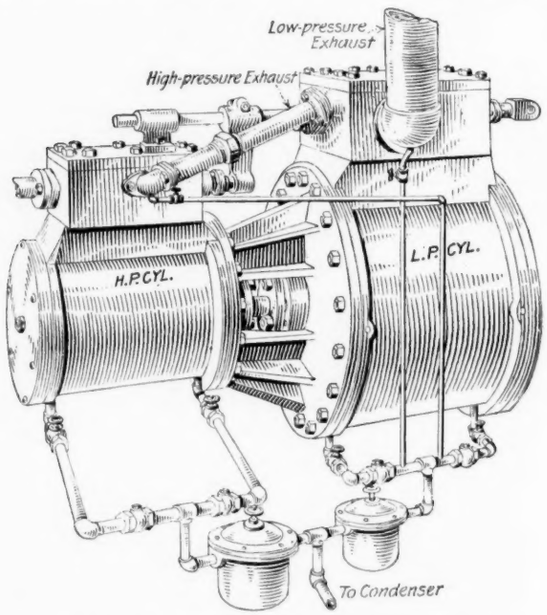
ment held on the top surface soon formed a cake which prevented the flow of oil. If this same surface is turned vertically, the sediment will continually work off, tending to keep the filtering material clean and permitting a much smaller surface to do the same work.

These are a few practical points that should be taken into consideration. A filter having the cloth properly arranged may be more efficient than another having ten times the amount of filtering surface. E. R. Higgs.

Milwaukee, Wis.

Piping Cylinder Drips

The accompanying sketch shows the cylinder-drain system of a compound condensing pump of the horizontal type. The discharge from the traps at present goes to the condenser, and the system works very well. I would like to have the readers of *Power* state what changes would be required in case of having to run the pump high-pressure, as the drains could not then go to the condenser. The cylinder drains of another similar pump are



PRESENT PIPING OF COMPOUND PUMP

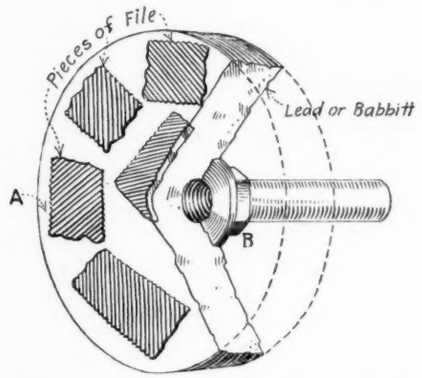
piped to traps that discharge to the atmosphere instead of to the condenser. When starting up, I do not always clear the low-pressure cylinder of water for some time, and think now that I shall have to discharge the traps into the condenser as with the other pump. This causes me to wonder how to arrange these drains in the event of some time having to run high-pressure. What would be the best way to pipe the cylinder drains, and is it advisable to discard the traps and run with the drain valves closed? The cylinders are not jacketed.

Chelsea, Mass. I. B. Rowland.

Facing Up Pump-Valve Seats

In the issue of July 18, page 105, there was illustrated a pump-valve facing tool made from an old file. I would suggest a tool made somewhat differently, as shown herewith, which will give more satisfactory results, as it has a larger bearing surface. The pieces of old file are cast into the babbitt-metal body and are so placed as to scrape the valve seat crosswise of the flutes in the file. Care should be taken that these pieces are not located with the flutes as at *A*, or they will groove the seat and it will be difficult to do a good job. The position of the files should be similar to that in drawfiling.

This tool is made by placing files on some plain metal surface, placing a ring or mold around all and pouring the babbitt into the mold so formed. On top and in the center place a nut, preferably a washer nut, as indicated at *B*, of such height that it will project above the



TOOL FOR TRUING UP VALVE SEATS

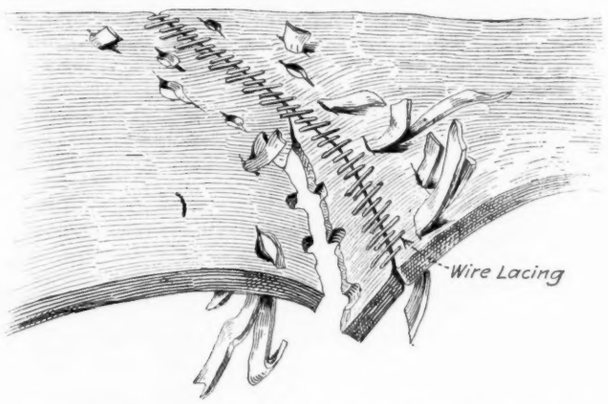
mold so that a socket wrench may be used for rotating the tool. Or if desired, a threaded driver may be screwed into the nut and the valve-seat facer rotated with an air drill or an ordinary carpenter's bit brace. The metal must be backed away from the files slightly.

This valve-seat tool is frequently used by pump repair men. Robert E. Newcomb.

Holyoke, Mass.

Comparative Test of Lacing

A way to prove whether a wire-laced joint is stronger than one laced with rawhide is suggested in the illustration. The two ends of an old belt are joined with wire lace without cutting off the holes used for rawhide lace, and it is then placed in a testing machine or loaded in some way so that the joint will be tested to destruction. The



OLD BELT JOINED WITH WIRE LACE AND TESTED

belt is likely to break through the old holes and not through the holes for the wire lace, because in the use of wire lacing no leather is lost and the strength is almost as great as in the original section.

New York City S. F. Wilson.

Inquiries of General Interest

"Concentration" in Boiler Water—In what sense is the word "concentration" applied to water in steam boilers when considered with reference to impurities or treatment for their removal? E. H. R.

The term may be used with reference to the accumulation of impurities or may refer to the formation of a compound with the whole body of the water in the sense of a concentrated solution.

Use of Rain Water for Feeding Boilers—What are the advantages or disadvantages of using rain water for feeding boilers? M. A.

Untreated rain water, both from its purity and the fact that it contains much air in solution, has a highly corrosive action on boilers. By the addition of a small proportion of lime or barium, the corroding action of the water can be neutralized, and boiler corrosion due to liberation of air from the water can be materially reduced by the use of an open feed-water heater.

Compound Rotary Converter—Can a compound rotary converter be operated inverted without cutting out the series-field winding? T. O. R.

A compound rotary converter may be used to change direct current into alternating current without cutting out the series-field winding, provided either the shunt-field or series-field leads are crossed from that for changing alternating current into direct current. If the series-field winding is cut out, the machine will have a better regulation, which means that the frequency of the alternating current will be more constant.

Size of Feed Pump for Boiler Plant—What rule should be followed in determining the size of feed pump for a boiler plant? G. L.

Ordinary power-plant boilers are likely to be forced 50 per cent. beyond their rated capacity and the pump should be capable of supplying the feed water thus required at a moderate speed, so that in case of low water in the boiler the pump may be speeded up and the deficiency made up promptly. Therefore it is good practice to provide feed-pump capacity of at least double the capacity required by the usual rating of the boiler plant. For power plants of 100 to 500 rated boiler horsepower capacity, using duplex steam pumps of ordinary dimensions, the above conditions will be met by an allowance of one square inch of water piston area to about 17 rated boiler horsepower and for the usual proportions of single double-acting pumps of usual dimensions, an allowance of one square inch of water piston to about 23 rated boiler horsepower.

Incandescent Lamp vs. Motor Load—What is the difference between a 120-amp. incandescent lamp load and a 120-amp. motor load on a 125-volt circuit? C. H. C.

There is no difference on a direct-current circuit, as the watts (W) in either case equal the volts (E) times the amperes (I), or $W = EI = 120 \times 125 = 15{,}000$ watts.

On a single-phase alternating-current circuit the difference would depend upon the power factor. The power factor of an incandescent lamp load is practically unity, while that of a single-phase induction-motor load varies with the type and the percentage of full load carried by the machine. Probably 0.75 would be a fair average value for the power factor of a single-phase machine under general operating conditions. The watts in either case are found by the formula, $W = EI \times PF$, where PF = the power factor of the circuit.

For the incandescent lamp load $W = 125 \times 120 \times 1 = 15{,}000$ watts, the same as for the direct-current circuit.

For the motor load, $W = 125 \times 120 \times 0.75 = 11{,}250$ watts.

Setting Steam Valves of Duplex Pump—What is the method of procedure in setting the steam valves of a duplex pump? W. T.

Place the pistons, on both sides, at the center of the stroke by moving them first in contact with one head and then the other, marking each position on the rod against the glands. Then on each rod place a mark midway between these two marks and move the rod until this central mark comes against the gland. When this is done on both sides, the valve motion rocker arms that connect with the crossheads should stand perpendicular to the piston rods. If for either side this is not the case, the crosshead must be disconnected and fixed at such a position on the rod as to correct the position of the arm. Next remove the steam-chest covers and place the slide valves in a position central to the ports and adjust the lost motion so as to have the same clearance on each end. If upon trial of the pump the steam piston strikes the head of the cylinder, take up some of the lost motion; if the piston does not make a full stroke, give more lost motion.

Size Required for Chimney Flue—What diameter of flue would be required for a round chimney 200 ft. high suitable for natural draft of 32 return-tubular boilers, each 72 in. diameter by 18 ft. long, containing seventy-two 4-in. tubes L. B.

The rated capacity of a return-tubular boiler of the dimensions stated is usually assumed to be 150 boiler hp., and 32 such boilers would be rated as 4,800 boiler hp.

According to Kent's formula, in which allowance is made for burning 5 lb. of coal per horsepower per hour to cover the contingencies of poor coal being used and of the boilers being driven beyond their rated capacities,

$$Hp = 3.33 \times E\sqrt{H} \text{ or } E = 0.3 \times Hp \div \sqrt{H}$$

where

Hp = Horsepower;
E = Effective cross-sectional area of the chimney flue in square feet;
H = Height in feet.

Substituting the given values in the second form of the formula,

$$E = (0.3 \times 4{,}800) \div \sqrt{200} = 101.82 \text{ sq.ft.},$$

and for a round flue the required effective diameter would be $\sqrt{\frac{101.82}{0.7854}} = 11.38$ ft., or about 11 ft. 4 in. diameter. To allow for friction, the diameter should be 4 in. larger, hence the actual diameter should be 11 ft. 8 in.

Calorimeter Test of Quality of Steam—The readings taken with a throttling calorimeter for determining the quality of steam delivered to an engine were as follows: Gage pressure in the steam pipe near the calorimeter connection, 135 lb. per sq.in.; temperature in the calorimeter, 232 deg. F. Considering the atmospheric pressure and also the pressure in the calorimeter to be 14.7 lb. per sq.in. absolute, what was the quality of the steam that was sampled and the percentage of moisture? R. L. G.

The quality of the steam is determined by the formula,

$$q = \frac{H + 0.48\,(t_2 - t_1) - h}{L}$$

where

q = Quality or per cent. of dry steam in the sample;
H = Total heat of a pound of dry saturated steam at the pressure that existed in the calorimeter;
0.48 = Specific heat of superheated steam as commonly taken for pressures near that of the atmosphere;
t_2 = Observed temperature of the steam in the superheating chamber of the calorimeter;
t_1 = Temperature of saturated steam at the pressure existing in the superheating chamber of the calorimeter;
h = Heat of one pound of the liquid entrained in the original steam;
L = Latent heat of a pound of dry saturated steam at the pressure of the steam sampled.

The absolute pressure of the steam sampled was 135 + 14.7, or practically 150 lb. per sq.in. absolute. By reference to the steam tables it may be seen that H = 1,150.4 B.t.u., t = 212 deg F., h = 330.2 B.t.u. and L = 863.2 B.t.u. As the observed temperature t_2 = 232 deg. F., by substituting,

$$q = \frac{1{,}150.4 + 0.48\,(232 - 212) - 330.2}{863.2} = 0.96$$

that is, the quality was 96 per cent. dry and there was 100 — 96 = 4 per cent. of moisture.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

"Standards for Electric Service"

SYNOPSIS—Abstracts are given of some of the general principles underlying an adequate and safe electric service and the reasons for the various rules and provisions of ordinances as suggested in a circular published by the Bureau of Standards.

Circular No. 56, "Standards for Electric Service," has recently been issued by the United States Bureau of Standards and is now ready for distribution. It contains 262 pages and may be obtained free by addressing a request to the bureau. It is believed that the proposals made in this circular represent the best practice in commission regulation and that the circular as a whole will be of interest and value to public-service commissions, to central-station operators and to municipal boards and commissions everywhere.

Chapter I discusses in some detail the factors entering an adequate and safe electric service. Chapter II is essentially a specification for the acceptance of types of watt-hour meters by public-service commissions and is a revision of the corresponding section of the "Meter Code." This revision was made with the coöperation and assistance of the joint meter committee under whose auspices the code was developed. Chapter III is a description of electrical standardizing laboratory equipment provided by state public-service commissions. Chapter IV is an exhaustive compilation of all public-service commission rules now in force, while Chapters V to VII are proposed commission rules and city ordinances for regulating electric service. Interesting tabulations of various kinds are given in appendixes, in addition to extracts from public-service commission laws.

Some of the suggestions in this bulletin that go toward promoting a safe and adequate electric service, which will be of general interest, are given in brief in the following:

There are in all electric services three general sets of conditions that very largely determine the adequacy and efficiency of any such service. The conditions are: Central-station operation; the transmission and distribution system; the energy measuring and translating devices.

In central-station operation, to provide an adequate and efficient electric service and make provision against emergencies, stand-by units and duplicate lines are important and should be provided where practicable. In many cases water-power central stations with auxiliary source of power such as steam or gas engines give inadequate service owing to the fact that these auxiliaries are of insufficient capacity to carry the load during periods of low water or other emergencies.

Central stations in the smaller towns at times find difficulty in supplying adequate service just at the time when most needed. Cases are not uncommon where house holders must provide oil lamps and candles for emergency lighting; yet economic and commercial limitations may preclude better service.

REGULATION OF GENERATING APPARATUS AND SWITCHBOARD INSTRUMENTS

The degree of uniformity of the voltage of supply circuits is perhaps the main criterion by which the public judges the adequacy and general excellence of electric service. This is because the candlepower of incandescent lamps varies widely with voltage variation and can be observed without test instruments or technical knowledge.

There are automatic voltage regulators on the market and in wide use, and they can be depended upon to keep the voltage fairly constant in value at any predetermined point on the circuit, usually at the busbars. Such voltage regulators, however, are not generally used, largely on account of initial cost. Probably less than 30 per cent. of the smaller stations use them. It can, however, be shown that the returns on the investment in automatic regulators for generators are sufficient to justify the initial expenditure even for small stations. In addition, the customer receives a greatly improved service, which in turn benefits the utility.

The switchboard voltmeter has been one of the most important of central-station instruments, and the quality of the service rendered by a station is very well indicated by such voltmeters. Graphic or curve-drawing voltmeters should also be installed, even in the smaller stations. They are especially valuable where conditions of voltage regulation are complained of by customers, and they are required by the rules of many state commissions.

Attention is called to the error that may be caused in the reading of the switchboard instrument due to faulty connection or overloaded current transformers. Although the voltmeter and ammeter are the most important instruments on the switchboard, and in fact are the only ones in many supply stations, it is necessary that other instruments be installed, such as indicating and recording wattmeters. In addition to this, in an alternating-current system a frequency meter is an essential to good service, as it shows the operator an indication of the constancy of speed and is necessary to comply with rules of certain states.

STATION RECORDS IMPROVE OPERATION

Electric service to be adequate, as defined by state commissions, must be reliable, and interruptions must be kept down to a minimum. In the rules of Pennsylvania an interruption is defined "for purpose of record only, as the interval of time during which the voltage falls below 50 per cent. of the standard voltage," while in Wisconsin rules an interruption is a "period of over 30 sec. during which the voltage on the circuit is less than 80 per cent. of its normal value."

Undoubtedly records of interruption showing the time, duration and cause of each interruption make for better operation of the station and better service to the public.

Station logs or records, showing time of starting and stopping machines, time of turning street lights on and off, and reading of station instruments are rightly required by many of the rules adopted by regulating commissions. Where only all-night service or services from dusk to midnight is furnished, such records are especially important. Full, complete and careful station records are of great value to the operating utility in rate and valuation cases, and no station is too small to keep a record of its operating, even though but one man is employed for all work. The effect of such records is to cause the operator to run his plant carefully, not only because customers will be benefited, but because the records will look better if the plant is carefully run.

The maintenance of constant voltage on distributing systems is of great importance, and the failure to maintain constant voltage is one chief cause for complaint from customers.

VOLTAGE REGULATION OF FEEDERS AND MAINS

The regulation of direct-current systems is most readily obtained by the interconnection of feeders and mains. These interconnections tend to relieve heavily loaded lines by throwing the load partly on adjacent feeders in the same network. In other cases, where large differences in the load or length of line exist, it often becomes necessary to operate several sets of busbars, each at a different voltage to which the distributing lines are connected, the longest line to the busses of highest voltage. On the very large systems motor boosters are used very successfully to meet special conditions of a temporary nature. On alternating-current circuits good regulation is most readily accomplished by voltage or potential regulators, either of the induction or step type. Induction regulators are made either for hand or for automatic motor operation and can ordinarily be relied upon to maintain a uniform voltage of all loads at the center of distribution to within about 1 per cent. As a big load will usually occur at different times on different feeders, and as the necessary amount of compensation (namely, increase or decrease of voltage) depends upon the load and the length of the feeder, it is evident that in many cases good regulation is possible only when each feeder is independently adjusted.

In addition to the voltage drop in feeders and primary mains, there is a voltage drop in transformers and secondary mains. These voltage drops cannot be compensated for by regulators, but must be taken care of by selection of transformers with good regulation, careful supervision of conditions of load on each transformer on the system, and the proper size of conductors for the secondary mains. Transformers sometimes become overloaded, owing to rapid growth of individual customers' loads, the number of customers to be supplied from one distributing point, an insufficient station record of transformer installation, and their connected loads.

Commission rules now enforced in some states allow only 3 per cent. variation in voltage, but there is lack of sufficient evidence to show definitely whether utilities generally can comply with the rules adopted. Systematic voltage surveys are not available, except in a few instances, and these seem to indicate that on mixed lighting and power service variations of 5 per cent. are not uncommon, even in the case of the very largest utilities operating under commission rules.

There are, of course, many situations where first-class service is not economically possible. In suburban or rural

districts or where service, if to be had at all, must be furnished direct from high-voltage transmission lines, wider voltage variations are justified and can be specified in any general commission rules. A reasonable rule, if definitely stated, with exceptions made for specific cases, will improve service and in the end benefit both utility and customers.

Losses are of various kinds, such as line losses, transformer losses, meter losses and air leakage and unaccounted-for losses. On lighting systems the losses at full load will usually be from 15 to 25 per cent. of the power supplied to the busbars, on the average alternating-current circuit. It has been estimated that about 14 per cent. of this loss is meter-shunt loss, about 50 per cent. transformer-core loss, and the remaining 36 per cent. is line and transformer-copper loss and leakage. A number of state commissions require careful record of station loads and output for purposes of proper accounting and reports.

The public-service commission laws of many states provide that it is not enough that an adequate electric service be provided, but it must also be safe. The general questions of safety in the operation of electric utilities are discussed in detail in Circular 54, of the Bureau of Standards. The following are some of the recommendations and reasons for safety in electric service:

GROUNDING LOW-POTENTIAL CIRCUITS

Proper grounding of low-potential circuits, such as direct-current three-wire and alternating-current two- or three-wire, is recognized as an important factor in reducing both the life hazard and fire hazard in premises supplied from low-voltage circuits, because of the possibility of accidental contact between these circuits and higher-voltage circuits. So many persons have been injured or killed by coming in contact with low-voltage conductors raised accidentally to high potentials above earth by contact with or leakage with high-voltage circuits, that the undue rise of potential above the earth in conductors to which the public has access should always be prevented by the use of effective ground connections on the low-voltage conductors.

The information available at present is not sufficiently complete to determine the safe limit to the voltage that may be allowed between an exposed ungrounded conductor and the ground. It is generally agreed, however, that voltages above 150 in commercial use are much more dangerous than those below 150 There is a strong tendency toward inclosing or otherwise guarding against personal contact all ungrounded conductors over 150 volts to ground.

There are several methods of widely varying value employed to secure electrical connections of low-voltage circuits with the earth. Driving a piece of metallic pipe several feet into the earth, or burying metallic plates, are common methods. Somewhat less common, but more effective, are continuous special-ground conductors and attachments to metallic water-pipe systems.

If a buried ground plate or a metal pipe or rod driven into the earth is used, it is necessary that permanent moisture level be reached, otherwise a permanent low-resistance ground cannot be obtained. Moist-conducting ground earth is not always within reach, and pipes or plates should never be used under such conditions.

PERMANENT GROUND CONNECTIONS

The most satisfactory method of securing a reliable and permanent ground is connection to underground metallic water pipes wherever this is possible. The resistance of pipe joints is usually low, the pipes present a large surface in intimate contact with earth that is always somewhat moist, in part due to the slight leakage of water, and most important, perhaps, of all is the fact that piping systems are electrically continuous with plumbing and heating fixtures with which people come in contact.

In general, it may be considered adequate to make the current-carrying capacity of the ground wire equal to that of the conductor to which such wire is attached. The National Electric Safety Code specifies that the ground wires shall not be smaller than No. 6 in any case, this being partly to assure sufficient mechanical strength.

It is important that the resistance of the ground be kept low, to reduce to a minimum the voltage drop due to current passing from the conductor to ground. If the resistance is not maintained at a low value, the current leakage to ground may not be enough to blow the fuse and relieve the dangerous conditions. Furthermore, the current leaking to ground will dry out the earth around the ground connection and destroy its effectiveness entirely.

Electric light and power companies are now subject to regulation by state commissions in more than half of the states of the Union and by municipal ordinance in a number of cities in states not having commission regulation. The supplying of electric service to the public is a natural monopoly, and regulation on behalf of the public is economically advantageous and necessary.

Owing to the very rapid development and constant changes in methods and apparatus, it has heretofore been very difficult to fix or determine standards for electric service. Developments are, of course, still going on, but the same general methods of electrical distribution, electrical measurement and methods of service are now very commonly used.

The popular movement for the regulation of public-utility corporations has spread rapidly since 1907, and at present there are corporation commissions, public-service commissions or railroad commissions in every state save three. In Illinois, Indiana, Montana, New York, New Jersey, New Hampshire, Nevada, Pennsylvania, Oregon, Washington, West Virginia and Wisconsin orders and rules for the regulation of electrical corporations have been issued by the commissions. Similar rules are under consideration in several other states, while a few commissions have so far issued only certain recommendations.

Circular No. 56, of the Bureau of Standards, discusses the most important factors constituting and promoting safe and adequate electric service, the circular being based on a careful study of the experience of operating companies and regulating bodies, both state and municipal. The circular contains, first, rules and recommendations for the regulation of electric-service companies by state commissions; second, three different ordinances suitable for adoption by towns and cities in states not having regulation by commission, the first for towns and small cities, the second for cities generally and the third for large cities having an electrical inspector); and third, specifications for the approval [illegible]s of electric meters by commissions.

The rules suggested as suitable for the consideration of state public service commissions are the result of conferences and correspondence with such commissions, and careful study and comparison of existing orders and rules.

The suggested regulatory ordinances for electric service in cities are based on a careful study of the subject and conferences with many operating companies and others qualified to express opinions.

Ordinances regulating electric service are so far in force in a very few towns and cities, and in most instances are limited in application to meter inspections and tests. Three different ordinances, varying in scope and length, so as to make them useful in municipalities of all types from small towns to the largest cities, are proposed and discussed. It is believed that these suggested ordinances will be of considerable interest and value to municipal authorities in cities and towns situated in states not having commission regulation of electric utilities.

A brief description of the electrical testing equipment provided by each state commission for the calibration and standardization of "working test standards" used by central stations in their meter work, and for making tests on consumers' meters upon complaint to commissions, is of interest to operating companies, and particularly to commissions considering the equipment of similar laboratories.

In appendixes are reprinted certain sections of state public-service commission laws, relating particularly to the regulations of electric service as to adequacy and safety, and in addition, tables and summaries on various phases of voltage regulation, meter testing and general central-station statistics.

The bureau asks for criticisms and suggestions from operating companies, commissions, state and city inspectors, committees of associations and engineering societies and all others interested in the establishment of proper standards for electric service.

PERSONALS

M. K. Foxworthy has been appointed manager of the Danville (Ind.) Light, Heat and Power Co.

Alfred Lotz, for many years with the Underfeed Stoker Co. of America, has resigned and joined the Moloch Stoker Co. in the capacity of vice-president and sales manager.

Henry Dusenberg, formerly with S. F. Bowser & Co., of Fort Wayne, Ind., is now sales engineer of the Thomas P. Ford Co., of New York, to succeed F. J. Miller, resigned.

William C. L. Elgin, who is a past president of the National Electric Light Association and second vice-president of the Philadelphia Electric Co., has been appointed chairman of the new committee on safety rules and accident prevention of the National Electric Light Association.

I. U. Jones has been appointed manager of the newly opened office of the Jeffrey Manufacturing Co., at Dallas, Tex.

W. V. Cullen has been appointed manager of the newly opened office of the Jeffrey Manufacturing Co., at St. Louis, Mo.

C. G. Hamilton has been appointed manager of the machine-tool department of Fairbanks, Morse & Co., Inc., at New York, succeeding George E. Neil.

B. L. Martin, after 27 years' continuous service with the Georgia Railway and Power Co., and for years superintendent of lines and conduits, has retired from the service. The high regard of the company for Mr. Martin was expressed in a valedictory addressed to him on his retirement, signed by the officers, department heads and many employees, accompanied by a gift of $200 in gold.

John I. Mange has been elected vice-president of the J. G. White Management Corporation, New York City. He has been associated with this concern since 1912, at that time having been elected vice-president of the Associated Gas and Electric Co., a holding company of electric and gas properties in New York, Kentucky, Ohio and Tennessee, conducted by The J. G. White Management Corporation.

MISCELLANEOUS NEWS

The Kent Light and Power Co., incorporated at Hanover, Ind., by James C. Reed, of Hanover, and others, will equip a plant to supply light to Hanover, Kent and other small towns.

The Explosion of a Boiler used in the operation of a portable sawmill near Crab Orchard, Ky., fatally scalded Joseph L. Smith, owner of the mill. The explosion was due to cold water being admitted when the water in the boiler was low.

Addition to Pumping Station at Louisville, Ky.—James M. Wilson, chief engineer of the Louisville Water Co., is completing plans and specifications for the construction of an addition to the pumping station of this company, bids for which will be taken during September. The cost of the improvement will be in the neighborhood of $300,000.

Recent Court Decisions

Digested by A. L. H. STREET

Liability Concerning Uninsulated Electric Wires—Although it is true that a company which maintains high-power transmission wires along places where persons are apt to come in contact with them must use the care to keep the wires properly insulated that is reasonably to be expected under the particular circumstances, the act of a boy in attempting to go from the top of a building in the course of construction to the top of a near-by tree and in falling on uninsulated wires below could not reasonably have been foreseen, and hence the company owning and operating the wires is not legally liable for the boy's injury in consequence of his contact with the wires under such circumstances. (Springfield, Mo., Court of Appeals, Williams vs. Springfield Gas and Electric Co., 187 "Southwestern Reporter," 556.)

Failure To Provide Safety Valve Is Negligence—The Kansas City Court of Appeals has affirmed judgment in favor of an employee who was injured through explosion of a sealed kettle in which asphalt was melted, finding that the jury was warranted in concluding that the accident was directly attributable to the employer's failure to provide a safety valve. Assuming that there was negligence in this respect, the court holds that the employee could not be prevented from recovering damages merely because a co-employee might have contributed to the accident through having overheated the boiler. The court, however, recognizes the principle that when there is no definite proof as to the specific cause of an explosion, it being attributable to any one of two or more causes for some of which the employer would not be legally responsible, there can be no recovery. (Amick vs. Kansas City, 187 "Southwestern Reporter," 582.)

NEW PUBLICATIONS

THE SLIDE RULE. By C. N. Pickworth. Sold in the United States by D. Van Nostrand Co., New York, 1916. Cloth; 5x7 in.; 124 pages; 39 illustrations. Price, $1.

This is the fourteenth edition of this very successful work and has been revised where necessary and the contents extended to include a section dealing with the solution of algebraic equations by the slide rule. Also, various new instruments are described. In the book will be found many practical hints, suggestions for solving formulas, methods of extracting cube roots and of finding small powers and roots, and a section on the determination of gage points, etc. An important part of the volume is the section devoted to examples in mechanical calculations, which embraces problems in mensuration, weights of metals, the steam engine, steam boilers, electrical calculations, etc. The work is a practical manual and should be very valuable to all who use the slide rule.

THE MARINE STEAM ENGINE. By R. Sennett and H. J. Oram. Published by Longmans, Green & Co., 39 Paternoster Row, London, England, 1915. Twelfth edition. Cloth; 6x9 in.; 502 pages; 417 illustrations. Price, $6 net.

Since the first two editions of the work, written by Richard Sennett, it has been practically rewritten in order to modernize it, and because of numerous revisions and additions made in several new editions, but little now remains of the original work. The importance of water-tube boilers has caused this subject to be dealt with at considerable length, 77 pages being occupied. The chapter on the marine steam turbine has been amplified and the details of the Parsons type of unit are fully illustrated. There is also a chapter devoted to internal-combustion engines, that appears for the first time in the work. This volume, although profusely illustrated, is void of the trade-catalog cuts, each drawing evidently having been made to illustrate the feature described. Each chapter is subdivided into subject heads in bold black-faced type, making it convenient for the reader to locate any particular subject covered.

THE MARINE STEAM TURBINE. By J. W. M. Sothern. Published by the D. Van Nostrand Co., New York, and Crosby, Lockwood & Son, London, 1916. Cloth, 6x9 in.; fourth edition; 561 pages; 330 illustrations. Price, $6 net.

The author is principal of the Sothern Marine Engineering College, Glasgow, Scotland. The book is intended to give a "practical description of the Parsons and Curtis marine steam turbines as at present constructed, fitted and run." It is greatly enlarged, containing as much again as previous editions. There is an abundance of inserted drawings and diagrams.

The various sections treat of the following divisions of the subject: Definitions and General Principles; Workshop Practice; Data from Actual Practice; Torsion Meters; Temperature-Entropy Diagrams; General Turbine Data; Impulse Turbines and Combined Impulse and Reaction Turbines, and Geared Down Turbines; Practical Operation of Turbine Machinery, Data from Practice; Shaft Horsepower; Condensers and Auxiliaries; Oil Fuel; Boilers.

As the author says on the title page, the book is for the most part descriptive. It should be a valuable addition to the libraries of those interested in marine-turbine practice.

SOOT IN BOILERS AND ECONOMIZERS

The Vulcan Soot Cleaner Co., Du Bois, Penn., has issued a 90-page booklet, 6x9 in., on the subject of cleaning soot from steam boilers. It cannot be classed as a catalog, as it is more of a treatise on the subject of soot as found in steam boilers burning various fuels. The frontispiece is a four-color reproduction of actual specimens of soot from different boilers with different fuels, and in itself is indeed instructive.

Section 1 of the booklet points out the composition of soot and shows that ash predominates in most soot. The paragraphs relative to the fusing of the soot are indeed interesting. Section 2 is devoted to a number of tests of boilers before and after being cleaned of soot, showing the steam consumption of mechanical soot blowers as compared with hand-blowing. Section 2 discusses the fundamental requirements of soot-cleaning apparatus and what can be accomplished with hand-blowing. Brief consideration is given to the growth of the size of the boilers and the height and volume of furnaces, the danger of accidents, the cost of labor, the space requirements, air leakage, loss of capacity—all of which tend to lessen the value of the steam lance as a soot cleaner. Section 4 treats of the design of the Vulcan soot cleaner as applied to different types of water-tube and horizontal tubular boilers, and Section 5 relates to the application of the cleaner to other types of fire-tube boilers, including the Scotch marine and the Manning.

Section 6 is devoted to the application of the cleaner to economizers with both straight and staggered tubes. Section 7, the last section of the book, treats of the design of nozzles, anticorrosion air-release valves and automatic telltale drain valves.

The booklet is by far the best treatment of the subject that has been placed before us. We understand that it is free to responsible persons interested.